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The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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The Death of King George V

IT is with a feeling of profound grief that we write these few words of recognition of the love and esteem held for his late Majesty King George the Fifth by the whole of the foundry industry, both at home and abroad. In our many contacts with foundrymen from the Dominions, we have been conscious that whilst the bond of technical interests had primarily brought us together, there was invariably the deeper feeling of being more closely related through the paternal influence of King George. His broadcast messages delivered in such statesmanlike yet homely phrases have done more to cement the Empire than all the diplomatic negotiations of the politicians, because they made us feel that we were all equally important members of one huge family, striving to make the world a little happier. King George came very close to his subjects, not only because of his ceremonial contacts, and broadcast speeches, but on account of his personal interest in industrial activities, and the sport of his subjects. The British Industries Fair owes much of its success to the practical interest shown by the late King and members of his family. The technical institutes have derived similar advantages from beneficent patronage. One of King George's sons, the Duke of York, is well versed in the art of founding, and when on one occasion he was visiting the Birmingham section of the British Industries Fair, and himself cast a souvenir plaque, he told Mr. W. O'Keefe that of all the departments he passed through during his training for the Navy, he liked most the foundry. Industry has also appreciated the visits made by the late King and members of his family to its workshops, and the prestige given to its products, when practical royal interest has been shown. The opening of the Mersey Tunnel and the launching of the "Queen Mary" are still fresh in our memory. The work of King George for charity was indeed a national asset, and thousands of ex-soldiers have found useful occupation as a direct result of the institution by him of the King's Roll. Universal grief will be somewhat softened by the thought that the Silver Jubilee celebrations were a source of great joy to the late King, as they enabled his people to express so enthusiastically their appreciation of their Majesties' long and strenuous work for the well-being of the Empire. Happily, with the passing of this great and much respected monarch, there is no feeling that history is to enter upon a new era. We believe that the new traditions so well and wisely established by King George will be carried on by King Edward VIII, who has made himself, by invariably following the precepts of his father, respected and beloved of his people.

Smokeless Fuel

Some remarkable men have started life as moulders, and it is appropriate that our attention should have been directed to one who may be described as the father of smokeless fuel during a winter in which fog has exacted a toll in damage, inconvenience and delay greater than usual. Thomas Parker was born in Coalbrookdale ninety-three years ago, and worked at the age of nine in the local foundries at fourpence a day for a fifty-nine-hour week. When he was 18 he worked at his trade as a moulder in Birmingham, Dudley, the Potteries and Manchester. Ultimately he went back to his old foundry and became foreman and finally manager of its engineering and chemical shop.

He then made a remarkable series of inventions. Before he was 40 he had patented the accumulator with the grid-paste plate, taking it out on the same day as the Frenchman Plante, and applied it to submarines, trains and motor cars, also developing other forms of transport as well. At the age of 61, in 1904, he invented the process of treating coal for making smokeless fuel by low-temperature carbonisation, and laid the foundation of what is now a commercially successful process of manufacture. The manufacture of coal gas, by high-temperature carbonisation, leaves a coke which is too completely deprived if its volatile constituents to be really popular for burning on an open fire, and the burning of raw coal, both industrial and domestic, is the cause of city fog. The wasteful use of our main source of wealth cannot be defended, particularly as the carbonisation of coal to make a smokeless fuel yields valuable by-products, rendering us less dependent on imported oil, and is actually carried out in cast-iron retorts. Smokeless fuel seems

(*Concluded on page* 82.)

Contents

	PAGE
The Death of King George V	81
Smokeless Fuel	81
Correspondence	82
I.B.F.—Election of New Members	82
Random Shots	82
Castings for Electrodeposition	83
British Industries Fair	84
Recording Thermometers for Core-Drying Ovens	84
Pulverised-Fuel Firing Without a Pulveriser	85
Refractories Research	87
Belgium Foundry Comptoir	87
The Report of the Costing Sub-Committee	88
Production of Centrifugal Grey-Iron Castings in Water-Cooled Moulds	90
Author of American Exchange Paper	91
Leaves from a Foundryman's Notebook	92
World's Largest Ingot Mould	92
Cupola Practice	93
Furnace Design	93
This Week's News in Brief	94
Trade Talk	94
Forthcoming Events	94
Raw Material Markets	96

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Perrits and the Follsain Process

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The difficulty experienced to-day by managers of industries in keeping in close touch with all the new developments affecting their products or processes is exemplified by the report of the meeting of The Institute of Vitreous Enamellers in your issue of the 2nd instant.

In the discussion following a most interesting and valuable address on the subject of heat-resisting alloys, the author was asked for information concerning the Follsain process. He frankly admitted he had no knowledge of it, and his subsequent suggestions in connection with it are very misleading.

As it is hardly possible for me to get into touch with all those present at the meeting, I venture to write pointing out that the Follsain Patents, the commercial development of which commenced only about three years ago, cover a wide range of metals and processes. That known as the Follsain "Penetral" HT process, which is no doubt the one the questioner had in mind, is not, as the lecturer suggested it might be, either a painting process or a new nickel-chrome cast alloy. It is a special cementation process, the object of which is to produce by impregnation and to the required depth within the metal of the article treated, a new alloy resistant to oxidation and to sulphurous gases at temperatures up to 1,000 and 1,050 deg. C. The resulting change in the composition of the outer portion of the original metal is due to the diffusion of some of the components of the treatment powder. The resulting alloy merges completely into the base metal, the physical properties of which are not adversely affected and the brittleness so frequently associated with treatments of this character is entirely avoided.

This HT process has been found very satisfactory for the treatment of perrits, except in those cases where periodical sand-blasting is necessary, and the ever-growing demand for its product in industries too numerous to mention here is the best possible evidence of its successful application.

I should be very much obliged if you would publish this letter in order to remove any misapprehension which may have been caused in the minds of your readers or the members of The Institute of Vitreous Enamellers as to the qualities and properties of this product of the Follsain process.—Yours, etc.,

GUY BARRETT,
Managing Director,
Follsain Metals, Limited.

Wycliffe Foundry,
Lutterworth.
January 16, 1936.

Smokeless Fuel

(*Concluded from page* 81.)

to be the answer to the British desire for an open fire, even if it is combined with the use of gas or electricity for starting up.

To-day H.M. Government is spending something like £80,000 per annum on fuel research, through the Fuel Research Board, involving the survey of the national coal resources, their detailed examination, and their treatment for making coke, gas and by-products. The hydrogenation of coal to make oil is also being carried out. In the various coke-producing areas, the production, treatment and testing of metallurgical and domestic cokes are being worked on by the Coke Research Committees, and few departments have more attention in industry to-day than those concerning fuel economy.

Election of New Members

At a Council Meeting of the Institute of British Foundrymen, held at the Charing Cross Hotel, London, on Saturday, January 18, the following were elected to various grades of membership.

As Subscribing Firm.

British Insulated Cables, Limited, Prescot, Lancs. Representative: Mr. S. C. Bullock.

As Members.

J. W. Monsey, commercial traveller, I. & I. Walker, Rotherham; W. H. Richards, engineer and ironfounder, W. Richards & Son; H. S. Wass, representative, Spermolin, Limited, Halifax; W. E. Aske, corebinder manufacturer, Halifax; C. H. Lorig, metallurgist, Battelle Memorial Institute; F. Webster, technical representative, August's, Limited, Halifax; G. Zenk, foundry engineer, Busselmann, London; F. Bainbridge, metallurgist, Skinningrove Iron Company, Limited, Saltburn-by-Sea; J. A. Lacey, production engineer, General Electric Company, Limited, Witton, Birmingham; A. S. Ward, managing director, Thos. W. Ward, Limited, Sheffield.

As Associate Members.

W. Ashton, foreman moulder, T. Robinson & Son, Rochdale, T. S. Baird, moulder, Wilson Bros.; R. C. Biggs, foreman, iron and brass foundries, Ceylon Government Railway; J. A. Braidwood, patternmaker, R. Taylor & Company, Larbert; W. J. Barber, assistant works superintendent, Midland Electrical Manufacturing Company; H. R. Dunton, foreman patternmaker, Qualcast, Limited; W. B. Holland, chemist, Wycliffe Foundry, Lutterworth; W. H. Hopkins, foundry inspector, Midland Electrical Manufacturing Company; R. Lee, student metallurgist, Keighley Laboratories, Limited; H. Horton, draughtsman, L.M.S. Railway Company, Derby; M. Pearson, foundry apprentice, Midland Motor Cylinder Company; E. C. Pigott, metallurgical chemist, Armstrong, Whitworth & Company; H. T. Brooks, patternmaker, J. Williams & Sons, Cardiff; J. Fletcher, iron patternfitter, Howard & Bullough; T. Freeman, moulder, W. H. Dean, Burnley; F. Gleave, charge-hand moulder, Platt Bros.; J. R. James, brass moulder, Metropolitan-Vickers Electrical Company; H. N. Mukherjee, foundry foreman, Manbloom, India; J. McConnachie, metallurgist, Coltness Iron Company, Limited; F. Oldershaw, foundry foreman, Modern Foundries, Limited; J. Potter, moulder, D. Owens, Monton; S. Singh, apprentice moulder, North Western Railway, Moghalpura; J. Smith, patternmaker, W. Slingsby & Company, Keighley; J. Wiggins, foreman patternmaker, T. Robinson & Son, Limited; W. S. Blincoe, chemist, Tees-Side Bridge & Engineering Company; E. E. Evans, student, Constantine Technical College, Middlesbrough; R. E. Fellows, student, Constantine Technical College, Middlesbrough; J. G. Hay, founder, H.M. Dockyard; E. Hinchliffe, B.Sc.(Eng.), research metallurgist, British Cast Iron Research Association, Birmingham, 3; F. Holberry, foundry foreman, Llanelly Foundry & Engineering Company, Limited; H. G. Maliphant, foundry superintendent, Llanelly Foundry & Engineering Company, Limited; C. H. Morgan, chief draughtsman, Llanelly Foundry & Engineering Company, Limited; F. N. Rand, foundry student, "Woodlands," Durham Road, Stockton-on-Tees; P. Reece, foreman moulder, Clarke, Chapman & Company, Gateshead; J. Stott, metallurgical chemist, Keighley Laboratories, Limited, of Keighley.

As Associates.

A. E. Byron, charge-hand, Dressing Shop, British Insulated Cables; R. Hargreaves, iron

(*Concluded on page* 91.)

Random Shots

There are few more pitiable sights than an abysmally-ignorant layman being led round a foundry by a too enthusiastic guide. Knowing nothing of foundry practice, he is denied the balm of sleep by the necessity of moving along from the sand-preparing plant to the knock-out, from the patternshop to the fettling department. It is for his especial benefit that the following Outline has been written in Mr. H. G. Wells' best vein. To read it is to understand all.

* * *

The novice will find the foundry the easiest shop to recognise, for the floor is composed of dirty-looking sand, the shop is full of dirty-looking men and the foreman is in a dirty-looking temper. The foundry manufactures iron, steel and brass castings, and the method of manufacture is of some interest.

* * *

The wooden pattern is placed in a box of sand which is rammed hard. The box is then opened in the middle and the pattern removed; a faint imprint of it is left in the sand. The box is then put together again and a hole is bored through the top part of the sand through which molten metal is poured into the cavity beneath. *The reader's natural acumen* will at once realise that the molten metal will take the same form and shape as the cavity originally made by the pattern. This it does, providing the sand does not fall in, a thing it very often does. After giving the metal time to cool, the sand is carefully brushed off and the resulting metal is then called a "casting." *It is then a porous substance full of cavities, technically known as blowholes.* The discerning reader will at once perceive that the process is simplicity in itself; the only catch is that if the casting is composed of 30 *per cent. more blowholes* than metal it is thereby declared null and void, and is called a "waster" (although the workmen have more expressive names for them). Wasters are boiled up again and when molten are re-poured into a fresh lot of sand—with mostly the same result *as before.*

* * *

It is very unlikely that you will be able to see the next processes which complete the castings, as these are usually carried out in an out-of-the-way corner of the shop, and for some reason or other visitors are seldom able to see them, but they are as follow. In the case of iron castings a bankrupt sculptor proceeds to fill all the blowholes with a substance known as iron cement, which gives the casting the appearance of a solid lump of iron. The artist or sculptor, call him what you will, then proceeds to add on any brackets, handles or other twiddlebits and whatnots which fell off when the casting was removed from the support of the sand. In the case of the steelfoundry, the blowholes are mostly filled with good quality electrodes, which are welded into the holes so as to fill them up. Vast quantities of electrodes are used in this manner, and electrode manufacturers mainly rely upon steelfounders for the sale of their products.

* * *

Most foundries are abominably noisy, cold and dirty, and you cannot hear what your guide is bawling at you, but you should gaze intelligently at him and nod your head in an understanding manner frequently. He will then shout his remarks once only, under the misapprehension that you can hear them, and this saves time and gets you out of the shop quicker, which is exactly what you want.

MARKSMAN.

THE ANNUAL dinner and dance of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen, which was to have been held in Birmingham on January 25, has been postponed.

Castings for Electrodeposition

TROUBLES EXPERIENCED WITH UNSUITABLE PRODUCTS

A well-attended joint meeting of the Midland Branch of the Electrodepositors' Technical Society and the Birmingham, Coventry and West Midland Branch of the Institute of British Foundrymen was held at the James Watt Memorial Institute at Birmingham, when Mr. B. Caplan, a member of the London Council of the E.T.S., gave an illustrated lecture on "Troubles Experienced in Electrodeposition due to Unsuitable Castings." Mr. L. Wright (chairman of the Midland Centre of the Electroplaters' Technical Society) presided, and was supported by the Midland chairman of the Institute of British Foundrymen, Mr. G. M. Callaghan.

The Case of the Plater

MR. CAPLAN first read a few extracts from a Paper on the plating of castings which he gave two years ago in London, and explained that his reason for so doing was that the position of faulty castings to-day was the same as then. The majority of castings passing through the polishing and plating shops, ferrous and non-ferrous, were rather poor in quality. The principal faults were probably sand and iron embedded in non-ferrous metals, excess of lead and/or zinc in brass, and castings improperly cleaned. Platers stipulated, he proceeded, that castings for plating were to be homogeneous and of good surface. His experience was that the first deliveries were always of good quality, but with each subsequent delivery the castings deteriorated in quality, and only urgency of orders and other time factors prevented their rejection. In any case, if the castings were rejected, the next batch would be just as good, or just as bad. All non-ferrous castings intended to withstand water pressure were pickled and hot-tinned in an effort to make them withstand pressure tests, and this was sometimes successful. The castings for electro-plating were similarly treated, and the polishers carefully avoided melting the solder in the pores during the buffing. So the finished casting sometimes passed inspection. Electroplaters get the same unfortunate results from every foundry. He did not wish to infer that they could not get good castings. They did occasionally.

Skin Porosity

Skin porosity was a problem affecting the pre-treatment of the work prior to plating. According to Mr. G. C. Pierce, this was caused by loose grains of sand emanating from various sources. The first was ineffectively cleaning the sand mould prior to teaming. It was surprising how, through carelessness and defective eyesight, sufficient loose grains of sand left in the mould could cause the polishers and platers a great deal of trouble, and even prevent the casting taking a high finish. Other causes of skin porosity, or speckiness, were weakness of the facing sand against the pattern, and incorrect position of the runners on the castings.

Relative Costs

A foundry colleague was indignant when the author protested about his castings, insisting that more cost for the grinding and polishing of the outer skin should be allowed. This usually meant removing quite a substantial amount of metal, sometimes of ounces, and often altering the shape of the article. It should be emphasised that in these days of large-scale production the cost of manufacturing an article was sometimes quite small compared with that of the polishing and plating. In fact, the cost of polishing and plating castings is often the most expensive part of the finished product, and firms' executives naturally looked askance at their costs. One could not blame them for this. Very often the plater had quoted, say, 4s. per doz. for polishing and plating certain castings, according to the samples submitted, only to find that the bulk delivery was so poor that the cost has jumped another 10 to 25 per cent. for polishing. Castings were frequently sent out from which the sand has been improperly cleaned. Here were two examples. Fifty-six pounds of castings were found to contain 5¼ lbs. of sand, and the author personally cleaned nearly 1¾ ozs. of sand out of a casting weighing 2 lbs. Foundrymen would probably call this an oversight.

Choice of Raw Materials

The indiscriminate use of badly-assorted scrap is responsible for many plating troubles. On one occasion a particularly bad lot of castings caused the platers to protest in no uncertain manner, and the answer, in a very apologetic tone, was that somebody had to have the bottom of the pot. Quoting Mr. Pierce, the lecturer said that, owing to lack of metallurgical knowledge by designers, or due to lack of consideration, defects will creep into castings, such as porosity caused by contraction of the metal. Designers will often indulge in violent changes of section, and the resultant castings will cause considerable embarrassment not only to the platers and polishers, but to most other workers and users.

Iron and steel filings were often found in non-ferrous castings. These were usually not very noticeable during the emery bobbing, but only after much labour and material has been expended. The compo mop cuts below the surface, leaving these foreign metals outstanding in long lines, something like file cuts. It has often been found impossible to remove these inclusions by grinding machinery without spoiling the shape of the article.

Too much lead and/or zinc in brass would, if the casting was made for polishing, give it a poor colour. If for plating, these baser metals would contaminate the alkali cleaning baths to the detriment of work following. Too much zinc would, in addition to this, contaminate the nickel solution. In any case the life of the nickel deposits may be affected.

Bright Nickel Plating

Mention should be made of an important discovery, namely, bright nickel. In the past nickel deposits came out of a plating bath milky white in colour. This made it necessary to finish or polish the nickel plate, which operation entailed the removal of a small amount of the plating. In bright nickel the casting emerges from the plating not quite brilliant. No polishing is required, and the advantages of getting castings with deep recesses finished in this condition direct from the plating bath cannot be overlooked. What it was desired to emphasise was this: bright nickel was going to bring about many changes in the plating shops, and to make it more than ever necessary for the foundry industry to supply a more suitable casting for electro-plating. Castings were not the only source of trouble, as invariably difficulties were experienced with hot stampings. The plater received excellent samples, but when the bulk deliveries commenced it was found that they usually deteriorated as badly as castings.

Details of the Plating Process

A description of how castings were plated, and what happened during the process when they were faulty or unsuitable, might be interesting to the foundry industry. The castings were dipped clean in aquafortis acid, if non-ferrous, and hydrochloric acid if iron or steel. They are then ground to shape and emery-bobbed. The friction between the emery bob and the casting heated the casting to a fairly high temperature. The heat contracted the pores of the metal and these absorbed the greasy lubricant used in the bobbing process. The castings were then grease-mopped, or buffed. The mop consisted of a large number of circular calico sheets stitched together, and ran at an approximate speed of 3,000 r.p.m. The mopping removed the emery marks; it also tended to flow the surface of the metal and partly close up the minute pores, open others, and at the same time imprison some of the grease. The casting was then dry-finished with a softer mop of calico or leather, and using a lime compound. It was finally rouge-finished if for lacquering.

A frequent source of trouble in porous metal here was spotting out. To avoid this the polishers will, if they know the job to be particularly porous, blow-pipe it prior to finishing. This was usually quite effective in avoiding spotting out after lacquering. In plating work of any type of metal cleanliness in its preparation was essential. Extra attention was devoted to castings. The work was first placed on boiling trichlorethylene. This denatured the polishing grease or compounds, or should do so. Unfortunately, in spite of this modern and most excellent cleaning process, a porous casting would still somehow hold the grease in its innermost pores.

Cleaning by Alkaline Bath

The work was then wired, or jigged, and placed in the alkaline cleaner, when a current of 6 to 8 volts was passed through it. This current formed a copious gas at the surface of the work, and any foreign matter still adhering was forced to the surface of the solution as scum, which was easily removed. After swilling in clean water, an examination may reveal very small grey-white spots at the opening of deep or bad pores, which had absorbed extra large quantities of grease and polishing waxes. In many instances, when the castings were being plated in bulk, these spots might be out of sight and were consequently overlooked.

Preparation of Non-Ferrous Castings

Non-ferrous castings were then etched in a cyanide or citric-acid solution. Ferrous castings were etched in a strong sulphuric-acid solution. The etching process, which is done electrolytically, provides a key for the subsequent plating, and if all the previous cleaning preparations had been correctly carried out, the junction of the base and plated metals should be as strong, or stronger than the base metal itself.

Sheets of steel, brass and copper were nickel and chrome plated and were afterwards cut, drawn or pressed into all manner of shapes, without damaging or peeling the plating. The work was now well swilled in running cold water and dilute acid, and then placed in the plating bath.

The nickel-plating solution usually consists of nickel sulphate, boric acid and sodium chloride; all chemicals used being of standard purity. The solution was warmed, air agitated and continuously filtered. All articles were wired or attached to the negative rod of the plating vat. Plating time varied with brass and iron articles, and also for work for window and door exposure, and mild and hard usage. The thickness of nickel deposited therefore varied from 0.0005 to 0.0015 in. (½ thousand to 1½ thousand), the latter figure giving quite admirable service for daily wear. The plated work is now removed, swilled in clear, running, cold and hot water and dried off.

Typical Defects

A close examination might sometimes reveal small bright spots round the pores of castings. These were caused by the various inclusions oozing out during the actual plating process. In most cases the agitation might be powerful

enough to wash away all the foreign matter as it oozed out of the pores, but where the work and porous part was screened, these bright spots form and might cause trouble later. Platers definitely knew that this foreign matter in a nickel bath helped to cause pitting in the deposited nickel. The plated castings were now highly finished by light buffing for chromium plating. If they have been bright nickel plated, the baffling was unnecessary.

Chromium Plating

Chrome plating, which came under Home Office regulations, was somewhat similar to nickel plating, except that a different solution was used and a very high current required compared with that employed for nickel. For example, an average car radiator would take 30 to 80 amps. in nickel plating, against 400 to 600 amps. in chrome. The gases or fumes formed during the chromium plating were dangerous to the operator, and so a special vent arrangement draws these fumes away from the plating shops into the open air. The operator was also compelled to wear gloves, apron, and boots made of acid-proof rubber. The castings were chrome plated for 10 to 15 min., and were then well swilled and left for a time to soak in a neutralising solution, usually of strong soda water. This eventually removed any chromic acid left behind in the pores. If this were not done effectively, the acid would in time damage the casting and plating. Inspection of the casting might sometimes reveal very small blisters round the pores, or near a joint. This meant that the plating must be stripped off and the process repeated from the beginning. Even though there may be no actual stripping, the fact remains that chrome shows up the slightest faults. A chrome-plated porous casting looks unsightly, and is no credit either to plater or foundryman. In many cases it is unacceptable, and the plater is always blamed for bad plating.

The fact that in spite of faulty metal the proportion of bad plating amounts to less than $\frac{1}{10}$ per cent. is a compliment to the plater, and is due only to the absolute thoroughness of the preparation and control of the various solutions. Even that $\frac{1}{10}$ per cent. is not allowed to pass inspection. Foundry supervisors please note this. A serious factor affecting both the foundry and plating industry is the competition of hot pressings, stainless alloys, and synthetic paints and lacquers. Platers have often been compelled through faulty castings and poor material to turn to hot pressings and stainless alloys. Many instances could be cited where, owing to bad surfaces, castings have been enamelled instead of plated. The remedy is obvious. Finally, the author expressed his thanks to Mr. Leonard M. Jones, managing director of Samuel Jones Engineering, Limited, for permission to present this Paper.

From the Foundry Angle

Mr. F. H. Hurren then took up the case for the foundrymen, and said that one of the main difficulties of the foundry is the fact that many customers order brass castings or gunmetal castings without any reservation that the castings are to be polished and plated, the only stipulation being "lowest possible price." Castings required for chromium plating were known in the trade as "medium fine brass castings for chromium plating," and the material should not contain more than 0.5 per cent. lead and 0.2 per cent. iron. Metal with a higher content of lead and iron was subject to segregation and porosity. This showed up in polishing and causes spottiness in plating. Mr. Caplan must realise that there was a considerable difference between putting work on an article which was in sight all the time, and making a casting by pouring molten metal into a mould, and hoping that every precaution had been taken which would result in a good casting. If the founder was forearmed with the knowledge that the castings he was making were to be chromium plated, he had the opportunity of making every effort to ensure clean castings by good clean moulds, poured with high quality metal carefully melted.

Carelessness Ruled Out

Mr. Caplan has stated that castings have been sent to him with the sand unremoved. There was no excuse for this other than carelessness on the part of the examiner or despatch clerk. He would realise that it was impossible for the manager to examine personally every batch of castings which left his works, with the result that a careless workman would cause trouble. The speaker had had polished castings returned to him with grease adhering. He could not accept Mr. Caplan's statement that, with each subsequent delivery, castings deteriorated in quality. This might be so in rare instances, but foundries which conducted their business on these lines would soon be out of business. It was possible to retaliate by saying he had had jobs done by polishers where the bulk of the work had not been as good as the sample submitted, on which they based their quotation. This, however, had been the exception and not the rule, and he would not like to deduce from isolated instances an uncompromising condemnation such as Mr. Caplan had made.

From Mr. Caplan's description of the methods of buffing, cleaning, nickel plating and final chromium plate, he inferred, and he thought Mr. Caplan would agree, that even with a satisfactory casting it was possible to obtain an unsatisfactory plating finish.

Essential Requirements

So far as brass castings were concerned, the following were essential requirements:—(1) A good clean mould well vented, and for certain types of casting the mould should be stove-dried; (2) New metal (not scrap) containing a maximum of 0.5 per cent. lead and 0.2 per cent. iron (copper content 68 to 69 per cent., zinc remainder); (3) metal should be carefully melted and moulds cast as soon as metal was ready, and (4) castings should be carefully fettled and sand blasted.

If these precautions were followed, a reasonable percentage of castings suitable for chromium plating should be produced, but the most optimistic founder would not expect 100 per cent. Some castings by their intricacy of shape, or large flat surfaces, presented extraordinarily difficult problems, and these could best be tackled by co-operation between founder, plater and user. In this connection he welcomed the joint meeting as a means of closer co-operation between associated trades.

British Industries Fair

The British Industries Fair, to be held simultaneously in London and in Birmingham from February 17 to 28, will be visited by representatives from 64 countries. It will cover an area in terms of actual exhibits, of 528,382 sq. ft., compared with 526,804 sq. ft. last year. There will be altogether 24 miles of exhibits, the stand frontage in London aggregating a total length of 12½ miles and that in Birmingham 11½ miles. There will be a total of 1,421 exhibitors.

(Concluded from next column.)

tube in a corresponding direction. By means of a simple and robust lever mechanism this movement is transmitted to the recording pen and recorded on a large circular chart (10 in. in dia.). The chart is rotated by clockwork, and is usually arranged to cover 24 hrs. The extreme fineness of the bore in the capillary tubing enables the recorder to be placed in any desired position away from the core oven, up to a maximum of 120 ft., without any risk of variations in temperature along the length of tubing affecting accuracy of the record.

Recording Thermometers for Core-Drying Ovens

In the modern foundry some form of pyrometer is now considered an essential to efficient production of castings, where but a few years ago it was thought sufficient to rely entirely upon the judgment of experienced workmen. It is now realised that the correct use of the pyrometer enables more exact repetition of conditions to be secured, with the consequent improved reliability and consistency in the quality of the product. Since the use of pyrometers has become more general, the output of good quality castings from large numbers of foundries has vastly improved, and the proportion of rejected castings has been greatly reduced.

There is, however, a direction in which further savings can readily be effected by means of scientific control. In many foundries core-drying ovens are used with only crude and inadequate means of checking and controlling the temperature, with the result that fuel is frequently wasted in raising the temperature to a higher point than is necessary or desirable, cores become overheated, and large numbers spoiled by burning. By installing suitably-designed recording thermometers, such as those made for the purpose by the Cambridge Instrument Company, of 45, Grosvenor Place, London, clear, permanent records can be obtained of the temperature variations in the oven, enabling the best conditions to be easily ascertained and accurately repeated. The Cambridge Core-Oven Thermograph has been in constant use in many well-known foundries, and by reason of its robust construction has proved exceptionally reliable over long periods of time. Many instruments have now been in use for several years. The instruments are comparatively inexpensive, and users have reported that the initial cost of the outfit is quickly repaid by the savings obtained, not only in fuel, but also in the prevention of spoiled cores from overheating and burning.

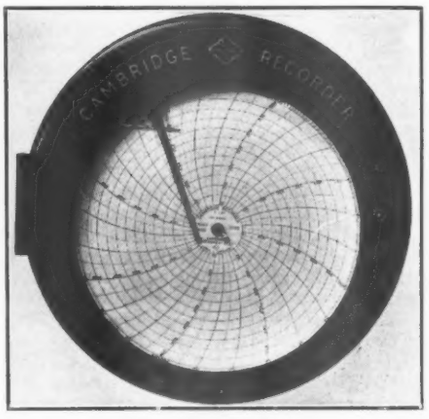

FIG. 1.—A RECORDING THERMOMETER FOR CORE-OVEN CONTROL.

The instrument referred to is of the "mercury-in-steel type"; that is to say, it depends for its working upon the expansion with temperature of a quantity of mercury contained in a steel bulb. This bulb, which is exposed to the temperature inside the core oven, is connected by a continuous length of specially-constructed fine-bore steel tubing to a "Bourdon" gauge tube situated inside the recorder, the whole forming a closed system which is filled with mercury. Any increase in the temperature of the core oven will cause the mercury in the bulb to expand, resulting in an increase of pressure throughout the system which moves the Bourdon

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Pulverised-Fuel Firing Without a Pulveriser

ADVANTAGES DERIVED FROM BULK SUPPLY

By Commander H. D. TOLLEMACHE

Pulverised coal is coal which has been prepared in a form so that it can be burned with equal cleanliness, convenience and efficiency to oil fuel. The principles governing the combustion of pulverised coal are, in fact, identical with those used in oil firing. In the same way that the oil from the burner enters the furnace in a fine spray, so that each tiny particle of oil is burned while in suspension, so also with pulverised fuel, the coal enters the furnace in the form of a fine powder and similarly efficient combustion is obtained. The wide variety of boilers and metallurgical furnaces in commercial operation to-day, showing in some cases years of successful working, testify beyond dispute the improved operating results which can be obtained from the use of pulverised fuel with properly-designed equipment.

Deterrent to Use of Pulverised Fuel

In 1934, only 129,170 tons of pulverised coal were used in this country for metallurgical purposes, representing but a tithe of the total fuel consumption in these industries, and being actually less than the quantity of oil used. It may rightly be asked why, if pulverised fuel really gives the successful results claimed, its use has not developed more rapidly in this country. The answer was given by the Secretary for Mines in his Annual Report for 1933, where, after giving figures for the consumption of pulverised coal in this country, he stated:—

> "The firms covered by the foregoing figures are operating their own pulverising plant. The capital cost of installing the plant has probably prevented a greater increase in the use of pulverised fuel by firms who would not feel justified in incurring the cost of installing a pulverising plant. It is therefore of interest to record that towards the end of 1933 the first plant of its kind in this country for supplying powdered fuel ready for use was opened at a colliery in South Yorkshire."

The views expressed by the Secretary for Mines certainly conform with those of the majority of people who have been associated with the development of pulverised-fuel firing in this country. Consumers appear to have formed the impression that the use of pulverised fuel is necessarily dependent on the installation of a grinding plant at their works, and that pulverised-fuel firing is merely a complementary adjunct to some form of pulveriser, which a salesman wishes them to purchase.

However fully a works manager may appreciate the advantages which pulverised-fuel firing would give in the operation of his furnace, the fact that it has also appeared to be necessary to install a pulverising plant, occupying valuable space in possibly an already congested works, has usually led him to the conclusion that "it would be more trouble than it is worth." When oil can be supplied conveniently and regularly in tank wagons, operate smoothly and silently with the minimum of attention and supervision, he somewhat naturally may become prejudiced in favour of oil firing as compared with pulverised fuel, if the use of the latter also entails coal-grinding plant.

These considerations seem gradually to have obscured the fact that pulverised coal is in reality a fuel in the same way that oil is a fuel, which has been prepared from coal in a form in which it can be used with the greatest efficiency. The use of pulverised fuel is no more dependent on the installation of grinding plant at a works than the adoption of oil firing necessitates installing a local refining plant; indeed, it is now realised that the grinding plant brings with it many disadvantages and no advantages.

Capital Outlay and Running Costs of Pulverised-Fuel Plants

In the first place, the elimination of the grinding plant saves probably some three-quarters of the capital outlay required for the use of pulverised fuel, and the equipment of furnaces becomes a simple and inexpensive matter comparing favourably with oil-firing equipment. The comparative cost of converting furnaces to pulverised-coal firing, with and without a pulveriser, is approximately as follows:—

	With pulverising plant.	Without pulverising plant.
Overall capital outlay for pulverised fuel-firing equipment per furnace	£750 to £1,600	£250 to £350

A comparison of the power and maintenance costs for pulverised-fuel firing equipment, with and without pulverising plant, shows that the bulk of these costs also are eliminated if the pulverising plant is dispensed with:—

	With pulverising plant.	Without pulverising plant.
Overall maintenance costs of pulverised fuel-firing equipment per ton of fuel ..	2d. to 6d.	Under ¼d.
Overall power required per furnace	15 to 35 h.p.	2½ to 3 h.p.

From these figures it can be appreciated that the supply of pulverised fuel in prepared form, thereby eliminating the necessity of installing grinding plant, constitutes a radical change in the whole economics of this form of firing. The savings derived represent a correspondingly greater return on the lower capital outlay, and the plant, instead of being a possibly doubtful investment, becomes a really profitable one.

Production Costs of Pulverised Fuel

As with other commodities, a high load factor is essential for economic production of pulverised fuel, when all charges contributing towards preparation costs per ton become correspondingly reduced. The cost of production falls rapidly as the output from a given plant increases, and few ordinary-sized works have so large a fuel consumption as to be able to operate a local pulverising plant at an economic output.

Where pulverisers are fitted as units to individual furnaces, they represent capital lying idle, still liable to depreciation charges, whenever the furnace is not in operation; and it will thus in most cases be possible to supply individual works with pulverised fuel produced in bulk from a central plant, at considerably lower cost than they could prepare it for themselves on site. This has already been appreciated in Germany and America, where unit machines already installed have in many cases been discarded in favour of receiving pulverised fuel in prepared form.

Importance of Consistency in Fuel

Quite apart from the question of economy of production, the supply of pulverised fuel in prepared form relieves the consumer of the care and attention which is necessary for the preparation of a consistent fuel. The importance of consistency in fuel for efficient combustion has been well appreciated by the oil and gas companies, who supply their fuel to consumers under rigorous specifications both as regards chemical analysis and thermal value. This feature is of equal importance in the use of pulverised fuel, where the lack of uniformity in chemical analysis, or even slight variations

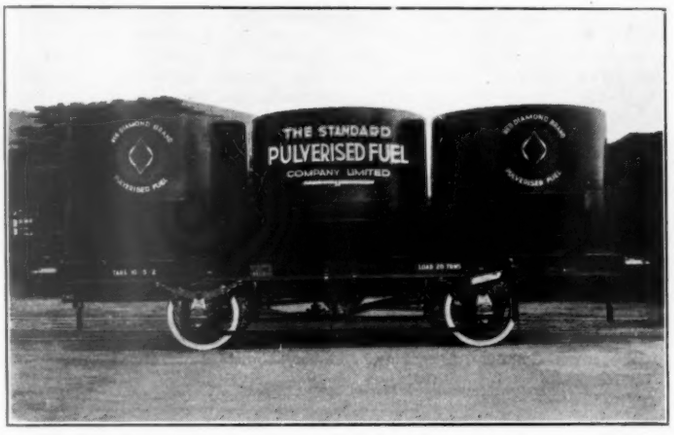


FIG. 1.—RAILWAY TANK WAGON FOR THE TRANSPORT OF PULVERISED FUEL IN BULK.

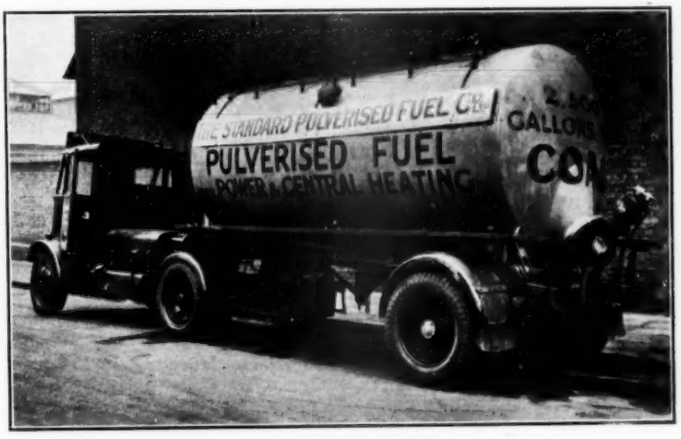


FIG. 2.—ROAD TANK VEHICLE FOR THE TRANSPORT OF PULVERISED FUEL IN BULK.

in fineness, will have immediate and adverse effects on furnace operation. It is true to say that the greater care with which pulverised fuel is prepared, the better will be the operating results and the greater the economies effected.

Correct Type of Raw Coal

A clean coal with the least possible ash content and other impurities is necessary for the production of a high-grade pulverised fuel, while high volatile content and low sulphur content are further desirable features. The coking characteristics of the coal are also known to influence not only the combustion period of the particles but, the radiant properties of the pulverised-coal flame. While we have in this country many seams of coal fulfilling these requirements, the burden of selection of the most suitable raw coal for the production of pulverised fuel should fall, not on the consumer, but on the producer of the fuel.

Importance of Consistent Fineness

Of equal importance to chemical characteristics is the question of accurate and uniform fineness. In the same way that good combustion of oil fuel depends on efficient atomisation of the oil by the burner, so with pulverised fuel successful results depend fundamentally on the consistency with which the coal powder itself is produced. Many failures with pulverised-fuel plants have been directly traced to the use of cheap and unreliable pulverisers, giving an intermittent and varying degree of fineness. On the other hand, the maintenance of an accurate fineness within close limits of specification is a specialised matter requiring constant supervision, and few works could spare the staff and time to give the continuous attention necessary. There is, indeed, something anomalous in requiring a factory, which may be engaged in work having nothing in common with the production of fine powders, to install plant and operate a highly-specialised process in order to obtain suitable fuel for its furnaces and boilers. The position is comparable to a works buying crude oil, and installing stills and refining plant to obtain its requirements of fuel oil and petrol. Oil refining is a highly-specialised process; so also is the production of high-quality pulverised fuel.

FIG. 3.—RAILWAY TANK WAGON BEING CHARGED WITH PULVERISED FUEL IN PREPARED FORM AT PRODUCTION PLANT.

FIG. 4.—PULVERISED COAL BEING DISCHARGED THROUGH A PIPE DIRECT INTO BUNKER AT CONSUMER'S WORKS. THE OPERATION IS CARRIED OUT WITH EQUAL CONVENIENCE AND CLEANLINESS TO OIL FUEL.

Supply of Pulverised Fuel in Prepared Form

The marketing of pulverised fuel in prepared form transfers all these problems from the consumer to the producer of the fuel, and enables the user to look to the supply of a fuel of guaranteed analysis and quality such as he would expect with oil or gas. It was with the object of making such pulverised fuel available to consumers in this manner, that the plant referred to by the Secretary for Mines above was erected in 1933. In this plant, which is shown in Fig. 3, pulverised fuel is prepared to a guaranteed specification, and is despatched as a standard fuel ready for use without further treatment. The original plant had a production of about 50 tons per week but the steady increase in the demand has led to successive extensions to the plant, which now has an output capacity of 1,000 tons per week. The erection of further production plants in other industrial centres through the country is now under consideration.

Method of Production

In preparing pulverised fuel at this plant the raw coal is first analysed for ash and sulphur content, and if not lying within the specified limits, the truck load is rejected. The raw coal is then dried in mechanical dryers until the free moisture has been removed, after which it is again tested to ensure that this has been done. The dry coal is then passed into the pulverised units and ground to a consistent fineness, the plant being arranged so that the fineness to which the coal is ground is capable of accurate adjustment. After grinding, samples are again analysed to ensure that the fineness specified has been correctly maintained, and the fuel is then conveyed mechanically into storage bunkers, where it remains until loaded into the road or rail-tank vehicles. The pulverised fuel thus produced is guaranteed to lie within close limits of specification as regards analysis, ash, moisture, calorific value and fineness.

Transport of Pulverised Fuel

Pulverised fuel is transported in bulk in the specially-designed rail and road tank wagons shown in Figs. 1 and 2. The railway wagons are either of the two-container or three-container type, and carry about 10 and 15 tons of pulverised fuel respectively. Fig. 3 shows a rail-way tank wagon being loaded with pulverised fuel at the production plant; on arrival at the consumer's works, the fuel is discharged pneumatically through a pipe direct into the consumer's bunker at the rate of about half-a-ton per minute, with equal convenience and cleanliness to oil fuel, all coal-handling about the works thus being saved. Fig. 4 shows a tank wagon during the actual process of discharging at a

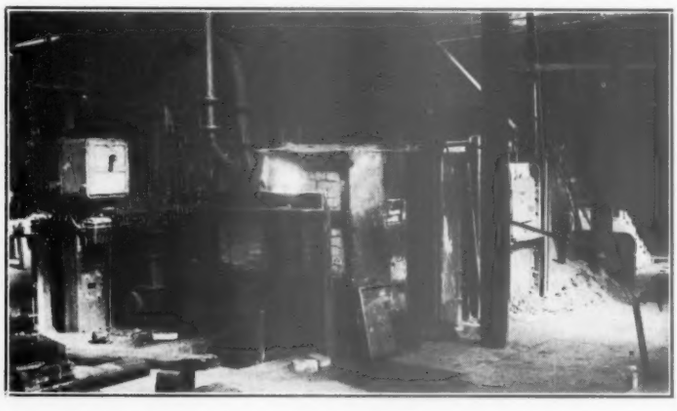


FIG. 5.—TYPICAL RE-HEATING FURNACE OPERATING WITHOUT PULVERISED PLANT, ON MARKETED PULVERISED FUEL.

FUEL	COST PER THERM.
ELECTRICITY SUPPLIED AT ½d PER UNIT.	15·0d
GAS SUPPLIED AT 1/- PER 1,000 CUBIC FT. 520 B.Th.Us.	2·3d
OIL DELIVERED AT 70/- PER TON OF 19,000 B.Th.Us.	2·0d
PULVERISED COAL DELIVERED AT 24/- PER TON. 14000 B.Th.Us	0·9d

FIG. 6.—COMPARATIVE COSTS OF FUELS PER THERM.

works. Fig. 5 shows a typical reheating furnace, running on marketed pulverised fuel, from which will be noted the simplicity and small amount of equipment required, when the pulverising plant is eliminated.

Application of Marketed Fuel.

A pulverised-fuel flame possesses very high radiant properties, which make it eminently suitable for metallurgical work of all types. Prof. Lander has stated that pulverised coal is actually superior to gas or oil as a fuel in this respect, giving a higher flame temperature and better heat transfer. This view appears to have been confirmed in cases where furnaces have been converted from oil or gas firing to pulverised coal.

In metallurgical work, furnace atmosphere control is as important as temperature control. In copper refining, for instance, it is known that the mechanical properties of the copper are directly affected by the oxygen content of the furnace, and the same applies in a greater or less degree in almost all melting, reheating or annealing work. Accurate control of furnace atmosphere is one of the great advantages to be derived from oil or gas firing for metallurgical work, and consumers have been willing to pay more for their fuel in order to be assured of this advantage. With pulverised fuel, equally accurate control is obtainable provided that the firing equipment enables the fuel feed and combustion air to be regulated with the same precision as with oil or gas, and that no variables which can affect furnace conditions are allowed to intrude.

In plants where unit pulverisers are used, directly coupled to furnaces, the furnace atmosphere cannot be controlled with the same accuracy as when the pulverised-fuel feed itself and the combustion air are independently and separately regulated. With unit pulverisers of this type the moisture evaporated from the raw coal passes into the furnace with the fuel, thus introducing a varying and unknown element which materially affects furnace conditions. Moreover, with unit pulverisers, wear of parts, atmospheric humidity, surface moisture and rate of feed all affect the fineness of the product and output of the mill, causing further variations in furnace conditions. When pulverised fuel is received in prepared form to a standard specification, all variations from these causes are eliminated, thus giving equally perfect control of furnace temperature and atmosphere to that obtained with oil or gas firing, but, as will be seen above, at about half the cost per heat unit.

Comparative Prices for Heat Unit

Given similar convenience and flexibility of control, the value of a fuel lies, from the consumer's point of view, in the quantity of heat which it can economically be made to yield, and the price which has to be paid for that heat. In this connection, pulverised fuel compares favourably with all other fuels giving similar convenience, such as oil, gas or electricity. In Fig. 6 is shown the comparative cost per therm of various fuels in, for instance, the Sheffield district, from which the outstanding cheapness of heat given with pulverised fuel can be noted.

Pulverised coal can thus now be regarded as a standard industrial fuel, giving similar advantages of convenience, cleanliness and flexibility of control to oil or gas firing, but at about one-half the price per heat unit. When supplied in prepared form, not only are the capital and running costs of the grinding plant eliminated, but also all the variations in furnace conditions arising from pulverising causes. Pulverised fuel can thus truly be described as "the cheapest source of accurately-controlled heat."

MESSRS. SPEAR & JACKSON, LIMITED, the Sheffield saw makers, have recently incorporated a new company—Spear & Jackson (U.S.) Inc.—and secured a factory in Tacoma, Washington.

Refractories Research

A statement of the research activities of the British Refractories Research Association is given in the Annual Report* of the Department of Scientific and Industrial Research for 1934-35, a summary of which is extracted here. An important stage in the advancement of research on refractory materials was reached in July, 1934, when The British Refractories Research Association equipped its own headquarters, the Mellor Laboratories, at Stoke-on-Trent. Prior to this the staff had occupied premises in the grounds of the North Staffordshire Technical College. The new laboratories represent the first independent institution in this country to be devoted solely to research into the problems of the clay industries and cognate matters.

Several researches have been conducted with the object of elucidating the factors which influence the texture of refractory materials and, thus, of giving more precise definition to the term, texture. For certain industrial operations the refractory materials are required to be of low porosity. A study has, therefore, been made of the extent to which this can be achieved by the application of high pressures. The porosity decreases in a logarithmic manner as the pressure increases. It is evident, then, that the use of very high pressures from the standpoint of reducing porosity may be an uneconomical proposition. Further, one of the difficulties involved in pressing mixtures with insufficient water to fill the voids is associated with the pressure gradient set up in the material in the mould. Such conditions may result in production of a pressed block which from the outset has a texture varying from the exterior to the interior. Differences of as much as 10 per cent. between the porosities of the internal and external portions of pressed blocks, 10 in. in thickness, have been reported.

For the same reason, the depth of the material in the mould exerts a marked effect on the density of the product. The investigations made have been concerned with evaluating these effects for mixes of different constitution as regards size of grain and containing different proportions of clay. During the progress of the work it has been discovered that other alterations in texture, distinct from the consolidation effected, but attributable to the process of pressing, are produced. This is due to the degradation in the size of the grains and consequent alteration in the proportions of the different sizes present. These investigations have been carried out using a relatively small mould in conjunction with an hydraulic testing machine. The problem of correlating the results obtained under these conditions with industrial practice still remains. In such practice, larger presses with much greater speeds of action are employed.

Durability of Refractories

The durability of refractory materials in many high-temperature installations is affected by the actions of gases and vapours as well as by slag and slag-forming substances in the solid and liquid states. The destructive action of the vapours from compounds of the alkali metals on refractory materials used in the construction of metallurgical furnaces and carbonising plants is of particular interest. During recent years, investigations on the subject of the attack of refractory materials by the vapours of different alkali compounds under various conditions have been in progress. For instance, the effects produced by subjecting typical products to the action (*a*) of the vapours from molten potash at 900 deg. and 1,000 deg. C. and (*b*) of the vapour from a molten potash-silica glass at 1,200 deg. C. have been studied. Another series of experiments has been concerned with the reactions of the vapour of potassium chloride at 1,000 deg. C., both under dry and moist conditions, with such materials. This work has revealed a striking difference in behaviour between silica and fireclay products. Another facet of the same general problem, which has proved of considerable interest, is a comparison of the rates of volatilisation from alkali impregnated refractory materials at 1,000 and 1,100 deg. C. Here, again, the behaviour of silica products contrasts strongly with that of fireclay bricks.

Blast-Furnance Linings

Examinations of the linings of blast furnaces by the staff of the Association have shown that carbon monoxide has often been responsible for the disintegration of firebrick into fragments at certain positions, with exceptionally serious results to the life of the furnace. An examination of these fragmentary remains showed them to contain appreciable quantities of carbon. It appeared that this carbon had been deposited at certain "spots" in the body of the lining material, and that this deposition has eventually resulted in the observed disruption. Comprehensive laboratory investigations on the effect of carbon monoxide on typical firebricks, mainly at temperatures in the vicinity of 500 deg. C. have been carried out. As a result of this work, the mechanism of the actions causing disintegration has been defined. Methods by which the effects of such actions can be reduced have been put forward.

In addition to the disintegrating action of carbon monoxide, there is definite evidence, including that obtained by the study of the condition of brickwork in the top zones of modern vertical gas retorts, which points to the fact that hydrocarbons can disrupt firebricks. The Association is now considering this problem. In one series of experiments, it has been observed that methane, on being passed at a slow velocity over test-pieces cut from certain firebricks, maintained at 800 deg. C. caused complete disintegration. This breakdown is connected with the deposition of carbon, and, further, as in the case of the action of carbon monoxide, the "iron spots" are concerned in the action. These researches clearly show that gases which can react with one or more of the constituents in the body of a refractory product may, in consequence of this reaction, so weaken the structure of the product as to cause its eventual breakdown. It is evident, then, that these investigations open up a very extensive field of research for, in industrial practice, many gases and vapours may play their part over a wide range of temperatures in causing the deterioration of a refractory lining.

* Cmd. 5013. H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. (Price 3s. net.)

Belgium Foundry Comptoir

A foundry comptoir, Comptoir des Fonderies Belges, has been established at Gilly, Belgium, to co-ordinate the commercial and technical practice of the constituent foundries. Members of the comptoir are: La Brugeoise et Nicaise et Delcure, Nouvelles Usines Rey Frères, Compagnie Centrale de Construction, Usines Victor Fontaine, Chaudronneries et Fonderies de Mariemont, and the Lambert Benjamin Piret concern.

A TURKISH IRON AND STEEL INDUSTRY.—Production of iron and steel is expected to begin within a short time in Turkey, according to a foreign official report. This development, it is pointed out, is a phase of the Turkish Five-Year Plan. All preparations for the creation of this industry have already been completed, and the Sumer Bank has engaged foreign experts to assist it in its task of establishing a metallurgical industry in Turkey. Projects submitted by various foreign firms which have offered to make the necessary installations are being carefully studied. It is reported that construction will commence this year and that the installation of the machinery will be completed two years later. The annual production of iron and steel in Turkey after 1938 is expected to be in the region of 100,000 tons.

The Report of the Costing Sub-Committee

When Mr. V. Delport, on behalf of the Costing Sub-Committee, presented their provisional report to the London Branch of the Institute of British Foundrymen, there was surprisingly little objection to the fundamental principles outlined. The discussion was opened by the BRANCH-PRESIDENT (Mr. F. O. Blackwell), a member of the Costing Sub-Committee, who said that the Report was the result of a good many hours' thoughtful discussion and analysis on the part of the members of the Sub-Committee, and he complimented Mr. Delport on the extremely able manner in which he had put into understandable language the results of the Sub-Committee's deliberations. He emphasised that the submissions made by the Sub-Committee were not intended to tie anyone down in respect of detail. The endeavour was to create a set of first principles by means of which founders could arrive at and use a somewhat more standardised and reliable method of costing. There might be many cases in which proprietors of businesses might find it expedient to modify the principles; with that the Sub-Committee was not concerned.

There remained quite an amount of other work before the Sub-Committee could complete the task assigned to it; in the meantime, Mr. Delport's Report was submitted for constructive and helpful criticism.

Costing per Casting

MR. W. B. LAKE, J.P. (Hon. Treasurer of the Institute and Past-President of the London Branch), proposed a hearty vote of thanks to Mr. Delport, and congratulated the Costing Sub-Committee on having put forward a thoroughly sound scheme for preparing the costs in the foundry. It was very pleasing indeed to note that the Sub-Committee proposed allocating a part of the costs to the actual melting department, a course which had not been very widely adopted, though it was very necessary if one were to have a proper balance of costs as between castings the production of which employed but little direct labour in the moulding department, and complicated castings which entailed more expense in the moulding and less in the metal. Mr. Lake also congratulated Mr. Delport for the very lucid and detailed manner in which he had presented the Report, having given every detail necessary in preparing costings up to the point he had reached. Of course, there were other things to be taken into consideration.

Discussing the basic principle of charging the cost of each job to that job, he said he did not see why in the metal department castings should be dealt with in sections requiring approximately the same amount of heads and gates, or, in other words, cases in which the yield of good castings was approximately the same. In that connection the members of the Sub-Committee seemed to be departing a little from their principles, because there were very few castings having exactly the same yield, and he considered that by far the better and simpler method, and one which was much more in accordance with basic principles, was to take the yield of each particular casting and to calculate each one on its own merits. That was the only criticism he had to offer on the whole Paper.

It was perfectly sound to divide the overheads, including the fixed overheads, in due proportions between the metal melting and the direct labour costs; that was the only practical method, and he was very pleased that the Sub-Committee had adopted it.

Overheads Based on Metal Melted and Good Castings

MR. DELPORT said that, whilst he might be responsible for the donkey work of writing reports and minutes, and so on, the actual constructive and spade work was done by the members of the Sub-Committee as a whole; any thanks expressed were due to them rather than to him individually.

Replying to Mr. Lake, he said that the division of castings which the Sub-Committee suggested for the melting department was not identical with the division suggested in the moulding department. There might be foundries making products in which the yield of good castings was heavy, and making also other castings necessitating the use of proportionately large quantities of heads, risers, and so on, and it was necessary that the overheads in the melting department should be based on the weight of metal melted, and charged on the basis of good castings produced. In cases where there was a relatively small yield of good castings, a relatively high proportion of overheads would be charged to labour in the moulding department, but in the melting department there would be a relatively low proportion of overheads, because it would be based on a relatively low weight of metal. That was the point which the Sub-Committee wished to make.

The Yield Factor

MR. A. YOUNG (a member of the Sub-Committee) supported the recommendation to distinguish between cases in which there was a large yield of good castings in relation to the total melt, and cases in which the yield of good castings was low. In this connection he mentioned a case within his own experience of a foundry having one section for rainwater castings and another section for heavy castings, such as ships' deck castings, the later products requiring the use of practically no gates and runners. The yield in the heavy-castings section would be probably 80 per cent. of the melted metal, whereas in the rainwater-castings section the yield might be only 50 per cent. That was why the Sub-Committee had suggested that an endeavour should be made to distinguish between the two types.

MR. LAKE said that his proposal was to carry that suggestion to its logical conclusion by ascertaining the yield of each separate casting and calculating the cost, instead of grouping the castings into classes.

MR. YOUNG replied that the Sub-Committee preferred that also, but did not wish to go so far as to recommend it as definitely practicable in every case. They had referred to classes of castings, but the proprietor of a foundry could regard that as meaning individual castings if it were expedient to do so.

Variation in Type of Output and Time Factor

MR. H. O. SLATER (Past-Branch-President), who seconded the vote of thanks, emphasised the importance of the periods over which the costs were built up, especially where a foundry was producing miscellaneous castings and was not divided into sections. He mentioned a case in which a casting was made in one foundry, and the cost of producing it was found to be considerable, whereas another foundry had made an exactly similar casting at about half the cost. On analysing the figures, it was found that the discrepancy in the first foundry was due to the system of building up the costs on a monthly basis, which was totally unfair, because during one month there might be very heavy work passing through the foundry, which would bring down the cost per ton, whereas during the next month there might be an excess of light and intricate castings, which would increase the cost per ton. It was found that, by adopting periods of one month, the estimates of costs were not balanced or constant. Therefore, the figures were analysed in order to find out the periods at which certain classes of work tended to repeat themselves, and the conclusion arrived at was that that period was 19 months in the foundry concerned. An average of the costs over 19 months was arrived at; at the end of each ensuing month, the figures for that month were added, and the figures for the first of the other 19 months were deducted, so that the average over the 19 months to date was arrived at. Thus, there was a fairly constant average throughout the year, covering both the heavy and the miscellaneous castings.

Expressing agreement with Mr. Lake's view that each job should be costed on its own merits, Mr. Slater said he had had to draw up a formula whereby each casting stood the cost of its heads and runners. That might appear to be very complicated; but once a system was established on a definite principle, it became quite a simple matter of routine work. In the first place, he obtained the rough weight, which was the weight of the head and the casting. When the casting was clean, one obtained the weight of head and arrived at the value of the scrap. By deducting that from the figure of rough weight, one arrived at the weight of metal in the casting and the total cost of the metal, which was the cost of the metal at the spout of the furnace. One also arrived at wages costs, overhead charges, miscellaneous stores appertaining to the particular casting, consumable stores used, and so on; the metal costs for special alloys were entered at a special rate. Finally, there was a column on the cost sheet summarising all the facts and showing the cost of the casting. It was surprising how well balanced the costs became.

Costing Related to Each Casting

MR. C. H. KAIN (Past-Branch-President) recalled that in the course of the discussion on the previous Paper, submitted (last session) by Mr. Delport on behalf of the Costing Sub-Committee, a good deal had been said about the value of home scrap. But he agreed very much with the Sub-Committee's recommendation as to the value of home scrap, and considered they had dealt with the matter very efficiently.

From the tone of the Paper and the summary of costs at the end, it would appear that costs should be taken out on the weight basis, *i.e.*, on the basis of a cost per ton or per cwt. of castings. It was becoming a very common practice, however, to supply castings at a price per piece. Therefore, he asked if the Sub-Committee had discussed the relative merits of costing on a tonnage and on a piece basis, and, if so, whether they had definitely concluded that it was best to cost on the tonnage basis. It was rather doubtful that the latter was the better basis, especially when one considered the figures given in the Paper for the cost of metal going into good castings, which presumably was the cost of the metal at the spout. If that were for estimating purposes, one was basing the cost of metal going into good castings on a hypothetical yield of good castings, and he suggested that the figure should be the cost of metal at the spout only. Once the metal was poured into the mould, its cost became the cost of metal per casting or per cwt. or ton of good castings. It was important that a decision should be arrived at as to the fundamental soundness of costing by weight or by piece, because that affected the first fundamental principle that the Sub-Committee had laid down, *i.e.*, that an expense incurred should be charged to the particular job. If the costs were taken out on the tonnage basis, the cost of heads, etc., was an average over the yield of the foundry; the cost of a head was not charged to the particular job, but a figure was arrived at representing the average cost of heads over a number of jobs going through the foundry at the same time.

It was advocated that the overhead charges in the moulding department should be apportioned to direct labour in money. Did not that assume, however, that the wage rates throughout a given foundry were the same? In the average foundry, employing both machine moulders and hand moulders, the hand moulders were paid more than the machine moulders. Therefore, under the system advocated for the allocation of overhead charges, a bigger proportion of overheads would be charged to the work of the hand moulders, because they were paid at a higher rate, although they were producing less castings than were the machine moulders, who were using expensive machinery. The overheads should be apportioned on the basis of the time occupied on the job, rather than on the basis of wages—unless the foundry were so organised that the wage rates throughout the moulding department were the same.

System Adaptable

MR. DELPORT, replying, said that various speakers might view the problems from angles which the Sub-Committee might not have visualised, and in answering the questions he must be regarded as speaking for himself and not as giving definite answers on behalf of the Sub-Committee. The Sub-Committee would study the constructive criticisms that were made and would endeavour to embody their views in the next report. The Sub-Committee were endeavouring to recommend a set of fundamental principles. Mr. Kain, when discussing the tonnage or piece basis, was dealing with estimating or pricing, rather than with checking costs at the end of a period. But it was not up to the Committee to recommend as to whether one should price castings at so much per ton, or per piece; one could apply the principles of the system to a tonnage price or to a piece price. Certain types of castings probably had been sold, and always would be sold, on a tonnage basis, whereas others would be sold at a price per casting. That was his answer to Mr. Kain, subject to observations which might be made by members of the Sub-Committee.

With regard to cost of metal, the Sub-Committee definitely arrived at the cost of metal at the spout per ton of good castings.

MR. KAIN pointed out that they were adopting the cost of metal at an earlier stage than that at which the casting had actually been made.

MR. DELPORT replied that the general question of costing was rather involved in this sense, that at the beginning one should decide whether one was dealing with estimating a job or checking costs at the end of a period; they were not the same problems. On the other hand, the principles of the system the Sub-Committee were trying to work out could be applied both to estimating a job and checking costs at the end of a period. In order to be able to estimate the cost of a job, one must have run a foundry for a period so that the information was available on which to estimate certain items of cost, the period chosen as a basis being weekly, monthly or any other. The Sub-Committee did not consider that a recommendation as to the basis period to be adopted was within their terms of reference. They could not say, for example, that a founder must cost on a weekly or a monthly basis, and he did not say that whether one costed on a weekly or a monthly basis would influence the final results. If the Sub-Committee were asked by the industry at large to study that particular question and to make recommendations on it, they were quite prepared to do so.

With regard to the point that the cost of heads, etc., came into the question of melting costs, he said that was the reason why the Sub-Committee had suggested that in the melting department the castings should be divided into different classes, because some castings had very large heads, whereas others had not.

Discussing the allocation of overheads in the moulding department, he said that admittedly the labour costs would be higher in respect of a casting made by hand than in respect of one made by machine, and if the overheads were based on direct labour or wages, the corresponding overheads would, in this sense, be higher in respect of the hand-made casting. Speaking personally, Mr. Delport said that that made all the difference between a foundry which was up to date and one which was not. If one could make castings more cheaply by machine, and reduce labour costs, why not make them by machine? If one made the castings by hand, and if they cost more than the machine-made castings, it was only fair that the overheads should be higher.

MR. H. O. SLATER, commenting on the reference to the cost of metal at the spout, said that the amount of scrap was credited against it.

Time Basis for Overheads

MR. LAKE suggested that Mr. Delport had not dealt quite accurately with the view that it was better to allocate the overheads in the moulding department on a time basis rather than the direct labour basis. The problem seemed to work out exactly as it should do, because, after all, the overheads were all based on the actual cost figures for the month or other period adopted, as already ascertained. In practice one found that the overheads on the machine moulding were very much higher than on the hand moulding, although the labour was cheaper in connection with machine moulding, and, in his opinion, that was exactly as it should be. The overheads were lower on the higher-paid moulders' work, for several reasons. One was that the hand moulder actually cost less than the machine moulder, because there were no moulding machines to be maintained, no compressed air to supply, and the moulder did not use so much sand in proportion to the wages he received, whereas one had to meet all those expenses in addition to the wages in the case of machine moulding.

As to the calculation of the price of the metal, Mr. Delport, apparently, had said that his calculation gave the cost of the metal in the casting; it would seem, however, that it gave the cost of the metal at the spout, and that one could only arrive at the true cost of the metal in the individual casting when one had ascertained the weight of the rough casting, including gates and runners, and had cut off the risers and runners, etc., and had allowed for them as scrap, charging the net weight at the full cost of the metal at the spout.

MR. DELPORT replied that in the melting department one would credit the scrap which was returned.

MR. LAKE said it was proposed to deal with the castings in groups, whereas he advocated dealing with each casting individually.

MR. DELPORT remarked that the Sub-Committee agreed with that as an ideal; but they had not been bold enough to recommend it generally.

MR. LAKE emphasised that it was the easiest method.

Repetition Castings per Piece

The BRANCH-PRESIDENT remarked that the Sub-Committee had had in mind foundries which were doing repetition work, producing large numbers of particular castings, and perhaps they had committed a sin of omission by not dealing specifically with the point of view of foundries which had to make perhaps only two or three castings of any particular kind for particular customers. There were foundries on more or less repetition work which were making no distinction!

MR. LAKE suggested that the greater the number of castings made, the more important it became to ensure that each casting was costed correctly.

The BRANCH-PRESIDENT agreed. He added that at his own foundry, although castings of many thousands of types were made, he could turn up the cost records and show the exact cost of any of those castings, as Mr. Lake had suggested. However, perhaps the Sub-Committee could supplement their recommendations on that aspect of the matter.

MR. DELPORT emphasised that the Sub-Committee had tried to make the principle absolutely as general as possible; that principle could quite well be applied to individual castings.

Commenting on Mr. Kain's remarks concerning the allocation of overheads in the moulding department on the basis of labour costs, he pointed out that moulding departments were in fact divided into sections, for machine moulding, hand moulding, and so on. Even though the wages of the hand moulders were higher than those of the machine moulders, the machine-moulding section had to bear the cost of depreciation and maintenance of moulding machines, which had a levelling effect.

MR. YOUNG, discussing the suggestion that time was better than direct wages as a basis for allocating overheads, said that the two really amounted to the same thing; wages might be paid on a time- or a piece-work basis.

Machine Moulding Overheads

The BRANCH-PRESIDENT said that the majority of the many thousands of boxes made at his foundry were paid for on the piece-work basis, and the wages represented a direct cost just as much as when time rates were paid. The term "direct labour charges" included either jobs that were paid for on a piece basis or on a time basis, with or without an output bonus.

The difference in regard to overheads as between machine and hand moulding was apparent; the overheads were small on floor moulding as compared with those on machine moulding. But there was the other side of the picture to be considered. The modern machine-moulding plants carried very heavy overheads which did not apply, of course, to floor moulding. The allocation of overheads on the higher rate of floor-moulding wages gave a much lower percentage overhead on the floor-moulding—the percentage was lower as the direct labour rates became higher. But where a thing had been made by hand for years, perhaps in insufficient numbers to warrant the making of press tools, and where it was decided to use press tools and to produce in thousands, using boy labour, one was told that the overheads had increased. That might be so; but the figures that mattered ultimately were the cost-card figures.

MR. W. O'KEEFE mentioned an occasion when he was associated with a very large firm that had extensive foundries, and he was requested to go into the costing on the production of steel castings that were then being produced, but as the firm had no previous experience to base their costs on, it proved that some of the orders in hand were definite "white elephants," as these castings were costing 100 per cent. more than the price at which the order was accepted.

Since the question of costing castings made on moulding machines has been raised in the discussion, here again it is important that each type of moulding machine should be costed out on its merits, as it was found from experience that the various types of machines working in the same bay had a considerable variance in the cost of production. He had occasion to ask the general manager of a very large foundry, who had been trained as an accountant, to go into the question of costing on the various types of machines they had in operation. Much to the general manager's surprise, he found that the cost per casting were much lower in the case of some machines than others, having taken into account the capital outlay, maintenance charges, and allowing for delays in production caused by breakdowns over a period. A man who worked hard in business, he continued, was entitled to

(*Concluded on page* 91.)

Production of Centrifugal Grey-Iron Castings in Water-Cooled Moulds

By H. W. STUART, Burlington, N.J., U.S.A.

(*Concluded from page* 14.)

Validates Theory

This assumption is based upon the results of many experiments designed to determine the cause of the results obtained by such a small amount of coating material. For instance, equally good results were obtained in one experiment where compressed nitrogen was used as a carrier gas in place of compressed air and the air inside the mould was replaced by nitrogen. Therefore, it was definitely established that the results obtained were not the result of any particular property of air.

It also was shown that if 200 grams of the ferro-silicon, which make it possible to cast a chill-free 12-in. dia. 18-ft. long pipe, were added to the molten metal required to cast this pipe, the increase in silicon content would be insufficient to have any effect whatsoever upon its chilling properties. Such an addition would increase the silicon content from 1.80 to 1.82 per cent., and it is known that variations in silicon content from 1.60 to 2.20 per cent. have very little effect upon the chilling properties of the metal. The foregoing observation presupposed that the pulverulent material combined chemically with the molten iron. That this is far from the truth is demonstrated by the fact that it can be brushed from both the outside of the castings and the inside of the mould, unaffected in composition and in noticeable amount.

These facts, the well-known refractory property of a gas film and observations such as the necessity of applying the coating material at a certain position in the mould just ahead of the iron stream, as shown in Fig. 6, led to the previously expressed assumption which will be investigated further in the future.

It already has been explained that the mould coating equipment does not interfere in any way with the normal operation of the DeLavaud casting machine. It can also be said that the mould coating material itself does not interfere with the operation for, although it retards the heat abstraction from the molten metal, the difference in the time required for the metal to cool to 815 deg. C., the temperature at which the pipe is extracted, has not been altered appreciably. As a matter of fact, whether or not a pipe contains chill or is chill-free is a matter of split seconds as it cools from its molten state.

It has been found that a number of pulverulent materials can be used effectively to prevent the formation of chill in the outside portion of the pipe wall, and it has also been found that certain materials, which will effectively eliminate chill, will not produce good outside surfaces.

Before passing from the method of producing chill-free or grey-iron castings in a steel DeLavaud mould, it should be emphasised that this was accomplished without changing the analysis of the iron used. A typical analysis of the cast iron is as follows, and no so-called graphitising elements are used nor are they desirable:—T.C., 3.65; Si, 1.80; Mn, 0.45; S, 0.075, and P, 0.85 per cent.

The results of physical tests made on pipes cast experimentally have shown that even considerable deviation from the foregoing analysis, as far as silicon, phosphorus and total carbon content are concerned, does not affect the quality of the pipe as much as does the lack of uniformity in cupola operation. To ensure uniformity of both analysis and temperature, forehearths have been installed at all of the chill-free DeLavaud units. One type of forehearth consists of a refractory-lined reservoir capable of holding approximately 12 tons of molten metal. It serves as a mixing ladle in which variations in the speed of melting, iron composition and temperature are reduced to a minimum.

The production of chill-free castings in water-cooled steel moulds is an interesting subject in itself, but the superior quality of the castings so produced is still more interesting to both the manufacturer and the consumer. To show the excellence of chill-free DeLavaud pipe, its physical properties will be compared with the physical properties of standard DeLavaud pipe cast directly against the metal mould.

In considering the physical properties of chill-free DeLavaud pipe, it is best to consider its properties as it leaves the mould of the casting machine, for it is in the mould of the casting machine that the fundamental metallurgical change in DeLavaud pipe has been made. The fractures of 6-in. standard and chill-free DeLavaud pipe in their "as-cast" state make the foregoing statement evident, as the standard pipe has a chill approximately half-way through its wall thickness. Its outside Shore hardness is 70 and in this state it is unmachinable, very brittle and quite unserviceable as a pipe. The

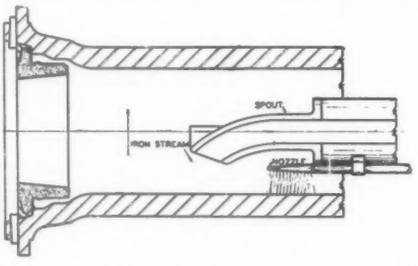


FIG. 6.—DIAGRAM SHOWING HOW THE COATING IS APPLIED IN ADVANCE OF THE IRON STREAM.

chill-free DeLavaud fracture shows it to be a grey-iron casting throughout. It contains only those constituents that are found in ordinary sand-moulded castings and it has an outside Shore hardness of 30. Unlike standard DeLavaud pipe, it is readily machinable and has sufficient impact resistance to be serviceable pipe.

After standard and chill-free DeLavaud pipe are annealed by the standard practice of heating to a maximum temperature of 925 deg. C. and cooling slowly to 650 deg. C. in approximately one hour, they both are grey-iron castings, having approximately the same hardness throughout their wall thickness. Since annealed standard and chill-free DeLavaud pipe have approximately the same hardness throughout, due to the reduction of the combined carbon in each to approximately 0.10 per cent., and since they both are cast from metal having the same chemical analysis, a great difference in their physical properties does not seem possible until the structures are examined under the microscope. Here it is found that, although they are constitutionally the same, their constituents form decidedly different structures, and it will be shown later that these structures have decidedly different physical properties.

Microphotographs taken from the outside, middle and inside of 8-in. standard and chill-free DeLavaud pipe show that the former has three separate and distinct structures; an outside structure which is chilled and has been reduced to balls of temper carbon in a ferrite matrix; a middle directional dendritic structure which is normal to the outside surface, and an inside graphitic structure which is composed of graphite flakes in a ferrite matrix. Chill-free DeLavaud pipe has but two distinct structures: a non-directional interlacing dendritic structure and an extremely fine graphitic structure at the middle and inside of the pipe wall.

Dendrites are formed at a rate of cooling slightly less than that which will cause chill and at a rate of cooling slightly greater than that which will cause a graphitic structure to form. Therefore, when the heat abstraction is retarded by the film of coating material on the mould, this structure is moved to the outside of chill-free DeLavaud pipe and, in doing so, it became non-directional. When large amounts of mould coating material are applied, as they were in previously known methods, this unique non-directional structure is not obtained, due to the excessive retardation in cooling the metal from its molten state. It is evident that such a non-directional structure would be very much tougher and resistant to a force that would rupture it, due to its interlacing nature, than would a directional structure in which planes of weakness are uninterrupted.

This description of the structures of standard and chill-free DeLavaud pipe is inadequate, but it will have served its purpose if it has demonstrated that, structurally, there is sufficient difference in standard and chill-free DeLavaud pipe to explain the physical test results reported subsequently. To see the real differences between these two structures it is necessary to study a panoramic view of the entire wall thickness.

Impact Resistance

The impact resistance of a cast-iron pipe is a most comprehensive and reliable indicator of its quality, for impact resistance cannot be obtained without both strength and ductility.

The full-length impact-test machine has been used for a number of years in determining the impact resistance of all kinds of pipe. This impact test, or a modification of it, is widely used by cast-iron pipe technicians and has proved to be an excellent indicator of the resistance of cast-iron pipe to shocks received in transportation, handling and in actual service. The pipe to be tested, while under an internal hydrostatic pressure of 65 lbs. per sq. in., is submitted to blows from a 50-lb. hammer. The initial blow for a 6-in. dia. pipe is from a height of 6 in. and succeeding blows are from heights increased by increments of 2 in. The pipe is held firmly in 24-in. supports and the blows are all struck at the same point. The number and height of the blows are increased until the pipe fails. The height at which the first crack and first leak appear is also noted and recorded. Three points on a 12-ft. pipe can be tested in this way since the failures produced do not leak sufficiently to prevent the water pressure being maintained.

TABLE I.—*Full-Length Impact Test* on 6-in. Standard and Chill-Free De Lavaud Pipe.*

Pipe.	Average height of hammer in ft. at Crack.	Leak.	Failure.
Standard unannealed ..	0.94	0.94	1.16
Standard annealed at 925 deg. C.	1.66	1.66	1.83
Chill-free unannealed ..	1.39	1.78	1.88
Chill-free annealed at 925 deg. C.	2.05	2.72	3.94

* Water pressure, 65 lbs. Initial height of hammer, 0.5 ft., 2-in. increments.

Table I is a tabulation of full-length impact-test results on 6-in. dia. standard and chill-free DeLavaud pipe, unannealed and annealed at 925 deg. C. These results are typical of the findings in many tests. It can be seen that annealing increases the failure height of standard pipe

from 1.16 to 1.83 ft., which is approximately the failure height of chill-free DeLavaud pipe unannealed. Annealing chill-free DeLavaud pipe increases its failure height from 1.88 to 3.94 ft. In other words, annealed chill-free DeLavaud pipe has an impact resistance more than twice that of standard DeLavaud pipe annealed. These chill-free DeLavaud and standard DeLavaud pipes had the same chemical analysis and, after annealing, their combined carbons were the same.

The same excellent impact resistance of chill-free DeLavaud pipe was also shown by full-length impact tests on 8-in. dia. pipe. Eight-in. dia.

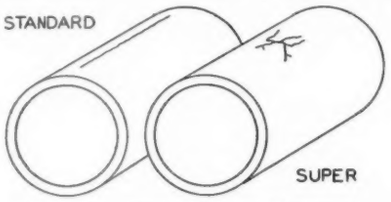


FIG. 7.—TYPICAL IMPACT FAILURES.

pipes are tested in the same manner as 6-in. dia. pipes except for the fact that the initial drop of the hammer is made from a height of 1 ft. instead of 6 in. Typical tests on annealed pipe show standard pipe failing at a hammer height of 2.88 ft., while chill-free DeLavaud pipe did not fail until the hammer was dropped three times from its maximum height of 5 ft.

Full-length impact tests not only showed that chill-free DeLavaud pipe has exceptional impact resistance, but also that it has characteristics which are very different from standard DeLavaud pipe. Fig. 7 shows the types of failure cracks which were obtained in this test. It will be noted that the standard DeLavaud failure is a single longitudinal crack which opened up soon after the leak occurred, while the chill-free DeLavaud failure consists of a number of short, tight non-directional cracks which can only be produced by actually indenting the pipe wall by a great deal of pounding after a

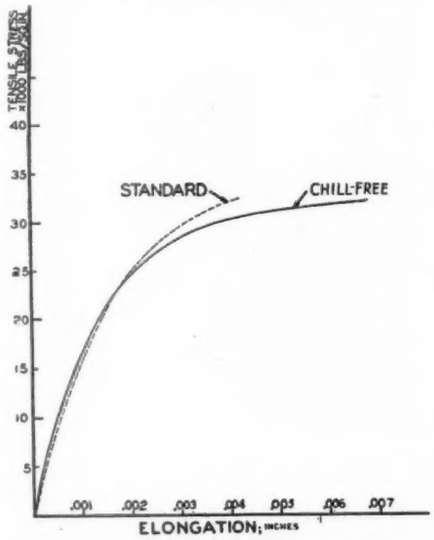


FIG. 8.—STRESS-STRAIN DIAGRAM OF A 0.505-IN. DIA. TENSILE-TEST SPECIMEN TAKEN FROM THE WALL OF A 12-IN. DIA. PIPE.

leak occurs. These types of failure are in accordance with the directional and non-directional structures shown by the microphoto structure.

The foregoing test results have demonstrated the fact that chill-free DeLavaud pipe is more resistant to handling shocks than standard DeLavaud pipe. As has been stated previously, this improvement is the result of high strength combined with ductility, as shown by the stress-strain diagrams in Fig. 8. These stress-strain diagrams show the stress in lbs. per sq. in. and the strain in in. per in., up to the point of failure of 0.505-in. dia. tensile specimens, taken from the wall of 12-in. dia. pipe. Chill-free DeLavaud metal is shown to have 62 per cent. greater elongation and, at the same time, its tensile strength of 14.2 tons per sq. in. is equal to the tensile strength of standard DeLavaud metal. Bursting-pressure tests also reveal the same high-tensile resistance as in the standard DeLavaud pipe.

Report of the Costing Sub-Committee

(*Concluded from page* 89.)

a reasonable profit, but the trouble in foundries, as in other businesses, was firms anxious to get business at a lower price than the other fellow, without having costed the job out properly, only to realise too late that they may be making a definite loss, in which case they were only spoiling the market for other foundrymen, who were robbed of the profits to which they were duly entitled.

Report Vindicated

MR. W. A. ELING said that some speakers seemed to be a little dubious, being under the impression that the principles enunciated in the Paper could be applied only to costing over a period; it seemed to him, however, that the principles could be applied quite as easily to a single casting as to the whole of the castings produced in a shop over a period of a week or a month. Having worked on somewhat similar lines, he did not think the members, having studied the principles, would find any difficulty in applying them to the costing of a single casting or to costing over a period. The system lent itself to a complete check with the financial books; by means of such a check, there was no likelihood of losses being overlooked in respect of overheads, and so on. The system was easy, and, if carried out properly, was, in his opinion, foolproof.

MR. F. GENTLES, supporting the vote of thanks to Mr. Delport and the Sub-Committee, mentioned a foundry in Scotland which dealt with ordinary green-sand floor and dry-sand moulding; there was a very large machine section, a good many cast-iron alloys were made, and there was also a fairly large malleable section. The costing system adopted there was very much on the general lines indicated in the Paper. The moulders' wages-cards and the core-cards (where cores were employed) were sent automatically each day to the accounts department, and there was no difficulty at all in costing any individual job. In respect of the costs of the ordinary floor moulding, or dry-sand or loam or machine moulding, a specific rate of overheads was charged, based on information which was very carefully collected in the shops; and during the reading of Mr. Delport's Paper it had occurred to him that the system adopted at that foundry was one which some day, perhaps, would have the approval of the Institute. The fact that foundrymen had become interested in costing represented a great advance.

The vote of thanks was carried with acclamation.

MR. DELPORT acknowledged on behalf of the Sub-Committee the expression of appreciation of their work; he also expressed his thanks for the help which the meeting had given in the various contributions to the discussion.

It appeared that the opinions of Mr. Lake and of the Sub-Committee were not divergent with regard to cost in the melting department. Mr. Lake merely wished to go further than the Sub-Committee had recommended, for he wished to regard each casting separately. The Sub-Committee did not suggest, of course, that the costs in the melting department should be spread over the whole of the castings produced, and Mr. Lake had not assumed that they did.

Author of American Exchange Paper

The American Foundrymen's Association announces that its 1936 Exchange Paper to be presented before the annual conference of the Institute of British Foundrymen will be given by Mr. Harold H. Judson, foundry superintendent, Gould's Pumps, Inc., Seneca Falls, N.Y. The Institute of British Foundrymen and the A.F.A., in 1921, initiated this annual exchange of Papers. Originally started to present reviews on developments in foundry practice between Great Britain and the United States, this movement led to the formation of an International Foundry Committee, which is composed of representatives of foundry technical associations of the leading countries of the world, including France, Italy, Belgium, Germany, Czecho-Slovakia and Spain, in addition to the U.S. and Great Britain. Through this committee International Foundry Congresses are held every three years, the last one being in Philadelphia in 1934. The next one is scheduled for Düsseldorf, Germany, next September.

Mr. Judson, who has been selected as the author for the 1936 Institute of British Foundrymen's Exchange Paper, is well known for his developments in the production of high-strength iron for large pressure pump castings—his Paper on this subject before the 1932 convention of the A.F.A. being especially noteworthy. He also discussed shear tests for cast iron before the 1931 meeting of the American Society for Testing Materials. Mr. Judson was born in Holyoke, Mass., and is a graduate of Worcester Polytechnic Institute of the class of 1923, receiving a degree of B.S. in Mechanical Engineering. Following his graduation, he was for three years foundry engineer with the Riley Stoker Company, Detroit. In 1926 he entered the employ of Gould's Pumps, Inc., as foundry superintendent.

Election of New Members

(*Concluded from page* 82.)

moulder, Howard & Bullough, Limited; L. Heap, chargehand, Brass Foundry, British Insulated Cables; H. Thompson, apprentice moulder, T. Foulds, Colne. The following are all associated with Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited:—W. Beeson, coremaker; H. Bennett, coremaker; J. P. Boyd, coremaker; W. Burton, coremaker; E. Charlton, coremaker; T. Chicken, moulder; C. Clark, moulder; N. Clarke, moulder; T. Davison, moulder; H. Dawson, moulder; E. Fairlamb, apprentice metallurgical chemist; R. Finlay, apprentice metallurgical chemist; G. Forster, moulder; T. W. Gibson, moulder; W. H. Hall, coremaker; H. Johnson, moulder; W. Johnson, coremaker; G. E. Patterson, apprentice metallurgist; N. Platts, moulder; W. Rea, moulder; D. Reece, coremaker; W. A. Robertson, apprentice metallurgical chemist; J. Shaftoe, moulder; J. H. Simmons, apprentice metallurgist; N. Simpson, moulder; J. S. Smith, apprentice metallurgical chemist; R. C. Smith, moulder; J. W. Stevenson, moulder; T. Stillwell, moulder; T. Stonehouse, purchasing agent; T. Storey, moulder.

As Students.

G. Clarke, apprentice moulder; S. Clarke, apprentice moulder; G. B. Crozier, apprentice patternmaker; J. R. Downing, Jnr., apprentice patternmaker; J. Gibson, apprentice moulder; W. B. Simm, apprentice patternmaker; J. Slater, apprentice coremaker; G. A. Stevenson, apprentice moulder; Wm. Wake, apprentice patternmaker; S. Gaging, apprentice moulder, Bryan Donkin Company, Limited, Chesterfield.

Leaves from a Foundryman's Notebook

VI.—ALTERNATIVE METHODS

By RECORDER

The majority of the castings produced in any foundry can be made in a number of ways, and often the pattern equipment supplied does not always favour the best procedure. What at first sight may seem the ideal way may, after a while, prove not to be as efficient as an alternative method. One of the great problems a patternmaker has to solve when faced with the task of constructing certain patterns is the decision as to the advisability of making his pattern a replica of the required casting or blocking out certain portions by a core.

The advent of oil-sand cores in the post-war years undoubtedly played a great part in the speeding up of production methods, but it led sometimes to uneconomic methods being employed. A number of examples can be called to mind where cores are an advantage and also other examples where they are not. Fig. 1 shows an example of the advantage of cores, while Fig. 2 illustrates the opposite. Both are end covers for high-speed engines, and possess a groove which is a part of the oiling arrangement of the job.

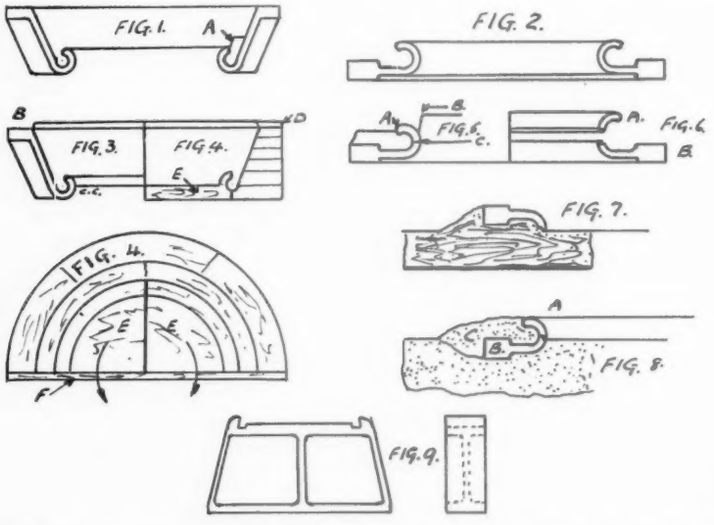


Fig. 1 is made in halves and bolted together to complete the full cover, while Fig. 2 is cast as a complete ring. The author has seen patterns for castings similar to Fig. 1 made practically a replica of the job, with just a print as at A. Into this print a number of sectional cores are placed to form the underlay part of the oil groove. An alternative method is shown in Fig. 3 and consists in coring out the whole of the interior of the job which is cast with face B down, the core extending from the print to line *cc*.

This arrangement makes for a stronger pattern, is easier to mould, and avoids the necessity of carefully nailing of three separate cores in place, to guard against lift, as is required by the first method. The core is made quite simply in a box shown in Fig. 4, which consists of a ring, forming the inside of the cover and fastened to a bottom board. The print portion D is dowelled on, whilst the portion E is turned to shape and cut in four pieces, two of which are used in this box. A loose end F completes the corebox. After the core is rammed up, the piece E is withdrawn by a circular motion in direction of arrows, and the coring up of the mould is a simple operation.

Fig. 2 was originally made for coring the prints being as Fig. 5. This was not at all satisfactory; a large proportion of the castings made were rejected because of imperfections, such as, for instance, the non-running up of lip A, Fig. 5, ragged edges to lip, etc. The diameter B of centre core had to be smaller than diameter C of ring core to allow of its being inserted in the mould, and the job was generally rather awkward and difficult to get clean.

After a considerable amount of trouble it was decided to make a complete pattern for this job in brass and use it similarly to a pattern of small sheave wheels, that is making a three-part mould in a two-part box. The pattern is illustrated in Fig. 6, which shows loose ring A fitting in ring B, whilst a joint-board completes the pattern equipment. This is shown in Fig. 7, a moulding box being placed on this, it is rammed up and turned over, and the board taken away. Pattern ring A is now put in position and the "floating joint" portion made as C in Fig. 8.

A top box is now rammed up and vented, which completes the ramming. The top box being lifted off, ring A of the pattern is removed, and the top box again returned to position, the whole is turned over, the bottom removed and ring B extracted. A splayed runner is now cut into this flange and the whole assembled. This is once again turned over so as to cast the face of the flange "down."

This method, although sounding rather complicated, was found in practice to be quite as quick as the former method, because no core making or assembling are required, which compensated for the little extra time required to make the "floating joint." Actually the number of rejects were reduced to practically a negligible quantity.

Fig. 9 illustrates another type of pattern where alternative methods can be adopted. In this machine age, half a pattern would on many occasions be considered sufficient, and each half mould would be rammed up separately. The two parts are assembled and the resultant casting is as required. This, however, all depends on the accuracy of the pattern setting and also of the box pins. The author has known of cases where the pattern has measured up perfectly for position, but the resultant casting has shown a considerable amount of "odding." This has been owing to the play between the box pins and holes, and is most noticeable in dry-sand work, where the box is subjected to the continual change of temperature within the stove and out on the moulding floor. This causes the box to scale and so alter somewhat in size. Consequently a number of "guides" have been devised to overcome this difficulty. One consisted in marking through specific points a line on the face of the mould and continued over to the side and assembling by these. Another method adopted is to use "sight guides" on the top box, while in other cases it has been deemed advisable simply to ram the bottom mould on a pneumatic machine and hand-ram the top.

In such circumstances how should the pattern in Fig. 9 be constructed? Should it be split as it would be for ordinary machine moulding, or should an alternative method be adopted? For this part-machine method it will be found that splitting the pattern along the centre is not the ideal way, as a deep top box will have to be used to accommodate the pattern, and considerable staying and liftering will have to be done to hold the deep box of sand intact. The alternative method of jointing along the top edge will be found to be the more economical; a shallow top-part box can be used, and all the liftering that would be required would be in the middle portion down to the centre rib.

World's Largest Ingot Mould

The illustration shows an ingot mould for making an ingot weighing well over 200 tons. The mould, which with the runners and risers attached, weighed between 165 and 170 tons, was made by the Brightside Foundry & Engineering Company at their Brightside works. It was delivered to the Vickers' works of the English Steel Corporation, Limited.

THE WORLD'S LARGEST INGOT MOULD.

Union Steel Corporation of South Africa

An offer is to be made to the ordinary shareholders of the Union Steel Corporation (of South Africa), Limited, to subscribe for 233,333 new ordinary shares of 5s. each at 6s. per share, on the basis of one new for every nine shares held. It is understood that the issue is being made to replace the expenditure incurred during 1935 on additional plant, and in the provision of additional stocks to cope with increasing business.

Cupola Practice

At a meeting of the West Yorkshire Branch of the Institute of British Foundrymen, held at the Bradford Technical College, MR. H. FORREST (Vice-President of the Branch) introduced a discussion on "Cupola Practice." The Branch-President (Mr. F. K. Neath) presided, and there was a large attendance of members.

MR. FORREST said he was sure they would all agree with him that efficient cupola melting practice depended not only on good coke, correct air supply and efficient maintenance and attendance, but upon perfect balance and combination of these items, for disregard of one of them might upset the whole scheme of things in the foundry, and the results of bad practice during one day's blow might cause quite a lot of unpleasantness for the foundry management for weeks to follow.

Coke and Slag Conditions

It must be borne in mind that coke which would be suitable for one size of cupola would not suit another, and, if one desired to control carbon pick-up, some brands of coke were better than others. It might be mentioned that hard coke which was dense was to be preferred, although it might not possess such rapid melting properties as the more open cokes did. Nearly everybody buying coke to-day demanded an analytical specification, but that was not the whole story. The specification could only be proved by practice.

The amount of limestone to be used would depend on individual conditions, such as freedom or otherwise of the pig-iron and scrap from sand and rust. Due allowance should be made according to these conditions. The colour and analysis of the slag would furnish an indication of the correctness of the practice. In general the slag should be fluid and of green or brown colour, and possess a vitreous appearance. Black, dead-looking slags containing a high iron content indicated insufficient limestone. It should be remembered that a correct fluid slag was not necessarily severe on the lining.

Control of Air Supply

Control of the air supply was essential to obtain the best results, and measurements of the volume of air passing into the cupola should be regarded as a necessity rather than a luxury, for while it was essential to have some data regarding the blast pressure, this was only of minor importance once it had been ascertained, providing the tuyere area remained constant. Special methods and types of apparatus existed for the measurement of volume and the constant air-weight blower, which controlled the weight of the air entering the cupola, irrespective of atmospheric conditions or resistance in the cupola, appeared to offer distinct advantages. This type of apparatus was necessarily higher in first cost than the more familiar equipment, but it might show savings in other directions due to increased efficiency.

Maintenance of the correct cross-sectional area of the hearth and melting zone in relation to the tuyere area should also be carefully controlled, and the policy of maintaining the original shape of the lining as bricked or rammed after each day's blow by careful patching should be rigidly adhered to. Variable results could be expected when the walls of the melting zone were allowed to burn back and so increase the area of the cupola at this point. After a long day's blow, the problem was not an easy one, but it was always worthy of consideration. Too low a blast pressure would very often cause lining troubles, and experiment was worth while on those lines.

Bed Coke

A very frequent cause of cold metal during the early stages of the blow was due to the bed not being properly burnt through before charging commenced, and it was also a good plan to put the fan on for a few minutes before any metal was charged. That allowed the coke in the hearth below the tuyeres to reach a high temperature, for once the tapping hole was closed this coke could only be kept hot by the molten iron, unless, of course, a receiver was used.

Another point was that in cupolas of small diameter large pieces of coke might bridge above the tuyeres and give a false indication of the height of the bed. A good poking through the tuyeres would correct this and charging might proceed if the bed was the correct height. Individual opinion varied as to the height of the coke bed, but if really hot metal was required from the commencement of the blow 28 in. above the top of the tuyeres was generally necessary. If the air supply was correct and the bed thoroughly incandescent before charging, metal could be tapped at 1,400 deg. C. at the spout day after day without variation.

Charges Must Be Weighed

For consistent results the weighing of all charges of metal and coke was essential and many foundries made their charges of metal too heavy. If it was realised that as each charge of metal melted and a correspondingly heavy charge of coke came into the bed it was obvious that conditions were not constant in the melting zone, with the bed altering in height as each charge melted; it was a good plan to make a circle of bricks corresponding to the diameter of the cupola shaft and to place therein a charge of coke. The result was in many cases surprising. The ratio of coke charges to iron charges varied considerably, but this need never exceed 10 per cent. in good practice, and 8 per cent. was sufficient in many foundries where a high tapping temperature was not essential. The impression that carbon was picked from the coke in the well while the metal was collecting was not supported by investigation and it had been definitely proved that iron remaining in the well for two hours showed no increase in carbon content. On the other hand the conditions in the melting zone where the temperature might be over 1,500 deg C. were favourable to carbon absorption by the charge. Hence the preference for coke having a low reactivity which was definitely known to carburise less readily.

Melting rate, with good practice, should be approximately 24 lbs. to 28 lbs. of iron per minute for each square foot of area at the melting zone, and on this basis it was quite possible to tap to a timetable and separate each charge as it melted, emptying the well with each tap to the point where signs of slag appeared at the tap hole. This was a very useful system where different types of metal were being melted in one cupola. Experience indicated the point where one mixture was blown down and the next put on, as a slight increase in melting time took place.

The PRESIDENT said he thought that Mr. Forrest had brought out the leading factors which would attract the interest of foundrymen who had to work cupolas. Mr. Forrest had had experience of various sizes and types of cupolas, but it would be interesting if any of those present could get up and disagree with him on any points.

A long discussion followed in the course of which points were dealt with by Mr. F. K. Neath; Mr. G. Hall; Mr. A. S. Worcester; Mr. W. G. Thornton; Mr. J. Smith; Mr. A. Proud; Mr. S. W. Hanson; Mr. W. Parker; Mr. G. A. Neild and others.

The proceedings ended with a cordial vote of thanks to Mr. Forrest.

MESSRS. HUGHES, BOLCKOW SHIPBREAKING COMPANY, LIMITED, Blyth, have bought the French steamer "Cephee" (9,680 tons), which is lying at Marseilles, for breaking up. It is understood the purchase price was £15,000.

Furnace Design

EXPERIMENTAL DATA

It is generally recognised that the engineer who wishes to work on scientific principles in designing furnaces is seriously handicapped by lack of adequate data, particularly for radiation and convection. With the object of providing more information, work has been undertaken during the past two years in the Mechanical Engineering Department of the Imperial College of Science and Technology, with the financial assistance of the Department of Scientific and Industrial Research, states the Annual Report* of the Department for 1934-35.

Until recently, radiation has generally been assumed to be relatively much less important than convection in the transfer of heat from the hot products of combustion in a furnace. Schack has pointed out that this was not consistent with laboratory determinations of absorption spectra, and he made numerical estimates of the radiation to be expected under various conditions from water vapour and carbon dioxide, the main products of combustion of all common fuels. The emission follows such complicated laws, however, that Schack's results are only approximate, and much of the work summarised below has been planned with the object of obtaining comparable experimental data.

Measurements of the heat transmission from the products of combustion of town's gas burned in a small furnace with varying proportions of excess air, and flowing at velocities of about 2 ft. per sec. through a 12-in. dia. tube of special heat-resisting nickel-chromium steel have been carried out over a temperature range from about 1,000 to 2,000 deg. Fah. The range of composition obtainable was from 22 per cent. water vapour and 8 per cent. carbon dioxide for the richest gas mixtures to 13.5 per cent. water vapour and 5 per cent. carbon dioxide for the poorest gas mixtures, which includes most industrial conditions.

The first step was to develop an accurate method of measuring the gas temperatures. Platinum/platinum-rhodium thermocouples in groups of three with wire diameters 0.02 in., 0.01 in. and 0.005 in. respectively were finally used, their indications being extrapolated to zero diameter.

Readings of both gas and internal tube wall temperatures were taken in four positions, at intervals of 2 ft. along the experimental tube, and the heat transmission was calculated by multiplying the temperature drop in the gases over each section by their mass velocity and mean specific heat. The heat-transmission coefficients so determined agree closely with Schack's figures and are of the order of more than ten times the calculated convection. For higher velocities, since convection increases with the 0.8th power of the velocity while radiation is independent of the velocity, this figure is reduced.

An alternative method of measuring the radiation is to focus it on to a calibrated thermopile, by means of a concave mirror, taking care that all radiation from the tube walls or lagging is cut off. This apparatus has been given a preliminary trial with promising results. Attention has also been given to the possibility of measuring separately the radiation from water vapour and carbon dioxide by the use of suitable absorbing screens.

THE SHEFFIELD CHAMBER OF COMMERCE states that while three years ago Sheffield was producing 64,000 tons of steel per month, production is now 134,000 tons per month. In highly-finished products the volume and variety have alike increased more than the crude output figures indicate. In the three years the number of unemployed has very largely decreased, and there is much less short-time working

* Cmd. 5013. H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. (Price 3s. net.)

This Week's News in Brief

Trade Talk

THE FORD MOTOR COMPANY, LIMITED, Dagenham, Essex, is now marketing its pig-iron direct from Dagenham.

BATHGATE DEAN OF GUILD COURT has passed plans for alterations at the Balbardie Steelworks of the North British Steel Foundry, Limited.

A SUGGESTION that Motherwell Town Council should urge the use of smokeless fuel in the burgh's iron and steel works has been turned down.

THE ENGLISH STEEL CORPORATION, LIMITED, held its staff dance at the Cutlers' Hall, Sheffield, last Friday. Over 500 people were present. A number of the directors attended.

THE GRAHAMSTON IRON COMPANY, LIMITED, petitioned the last meeting of the Falkirk Dean of Guild Court for permission to erect a new warehouse and buildings at their foundry. The Court unanimously granted the application.

MESSRS. ALEXANDER STEPHEN & SONS, LIMITED, Linthouse, Glasgow, have received an order to build a cargo steamer for the Clyde Shipping Company, Limited. The vessel will be 270 ft. in length and designed for a speed of 13½ knots.

THE STANTON IRONWORKS DIVISION of the St. John Ambulance Brigade held their annual dinner at the Ironworks Club House, Stanton-by-Dale. Mr. E. J. Fox, managing director of Stanton Ironworks, presented awards to members who had passed the brigade examination.

AT A COUNCIL MEETING of The Institute of Vitreous Enamellers, held in Manchester, Mr. Roger Sorton Darby, of Messrs. Darby & Company, Guildhall Buildings, Navigation Street, Birmingham 2, was elected an ordinary member, and Mr. Joseph Doncich, of Messrs. Edward Curran & Company, Limited, Docks, Cardiff, an Associate member.

A FIRE AT THE brass foundry of Charles S. Madan & Company, Limited, Altrincham, Cheshire, on Monday evening burnt out a storeroom, destroying its contents. The fire brigade prevented the flames from spreading to the works themselves. The works are situated in the centre of the industrial area of Altrincham. Arrangements have been made to carry on business as usual.

MESSRS. HURST, NELSON & COMPANY, LIMITED, Motherwell, have received a contract for fifty 12-ton coke wagons for Messrs. Charrington, Gardner, Locket & Company, Limited, London. They have also an order for the supply of 12 bogie passenger underframes, complete with wheels and axles and with roller-bearing axleboxes, for the Egyptian State Railways Administration.

THE ANNUAL DINNER and dance of the Manchester Association of Engineers will be held on Friday, March 6, 1936, at the Manchester Limited Restaurant, Royal Exchange, Manchester. A short entertainment will be provided during the evening. Tickets, exclusive of wines, at 8s. 6d. per person, can be obtained from the secretary, Mr. T. Makemson, St. John Street Chambers, Deansgate, Manchester.

THREE CARGOES of scrap iron, totalling 19,500 tons, were unloaded at Glasgow last week for Lanarkshire steel firms. This is believed to be a record for Scotland, and other large cargoes are on the way. Steel manufacturers are making steel with a mixture of scrap and pig-iron, and will continue to use this blend while scrap is cheaper than iron. Two consignments of iron ore amounting to 10,000 tons have also arrived for iron manufacturers.

MESSRS. DAVID BROWN & SONS (HUDDERSFIELD), LIMITED, will begin production, at their Penistone Works, on Friday. It is hoped to make the first cast in the afternoon. Later it is the intention to transfer all the company's foundry and forge departments to this site. The most modern lay-out, equipment and new processes will be adopted, and when the transfer from Huddersfield of departments concerned is completed, the output will greatly increase.

MR. SEAN LEMASS, the Irish Free State Minister for Industry and Commerce, last week opened new extensions to the Hammond Lane Foundry, Dublin, in the presence of the directors, officials and many public representatives. He was presented by Mr. David Frame, the chairman, with a silver-cased electric clock as a souvenir of the occasion. Twenty-five workmen who have had over 25 years' service with the foundry also received a suitable memento of the occasion.

CLYDESIDE ANTICIPATES large contracts from Russia for the iron and steel and manufacturing firms. Big orders were executed by Colvilles, Limited, William Beardmore, Babcock & Wilcox, Stewarts and Lloyds, and other concerns for Russia in 1935. Trading representatives have been in Russia consulting the Soviet experts, and beneficial results are expected at an early date. Russia was one of the largest buyers of West of Scotland iron, steel and boiler tubes and other products last year.

THE DIRECTORS of the Coltness Iron Company, Limited, announce the resignation of Mr. William H. Telfer from the managing directorship of the company as from April 4, 1936. At that date Mr. Telfer will become vice-chairman of the Coltness Iron Company, Limited. Mr. David Barr has been appointed to succeed Mr. Telfer as managing director of the Coltness Iron Company, Limited, of which company he is already a director. Mr. Barr will retain the managing directorship of Wilsons & Clyde Coal Company.

A DUBLIN NEWSPAPER this week reports that an Irish iron and steel making industry, capitalised with two and a-half million pounds, is visualised by the promoters of Irish Minerals, Limited, a new company for which application for registration is being made in Dublin. Official confirmation of the report is so far lacking. According to the statement, Irish Minerals, Limited, was to be a holding company which would be succeeded by a two and a-half million concern as soon as the mineral potentialities of the Arigna district of County Leitrim had been established. It is also said that the company was in association with the Duffield Iron Corporation, Limited.

THE PROPOSED REOPENING of the Jarrow Steelworks by a new company has been carried a step further. Mr. E. Hargreaves, the Jarrow representative of Messrs. Thomas W. Ward, Limited, of Sheffield, who at present own the steelworks and blast-furnaces, has announced that option holders have agreed to take over the whole of the site from Messrs. Wards, and negotiations in this connection have been completed. Dismantling operations have been carried out during the past few months at the steelworks, and these are to be speeded up to clear the land for the new plant which will take two years to erect. It is understood that there is £1,000,000 capital behind the Jarrow scheme. The proposed plant will have an output of 500,000 tons of steel per annum and it may be decided to lay down a coke-oven plant also. The Tyne Commissioners are expected to begin work shortly, repairing the old Jarrow jetty in readiness for the new firm.

Contracts Open

Hull, January 29.—Iron castings; pipes and gullies; iron and steel, for the City Engineer's Department. The City Engineer, Guildhall.

Newport (Salop), February 1.—Provision and laying 9,300 yds. of cast-iron supply mains varying in diameter from 4 in. to 3 in., for the Rural District Council. Mr. J. R. Elliott, clerk. (Fee £3 3s., returnable.)

Laleham, February 8.—Two sets, each in duplicate, of pumps, electric motors, switchgear and cast-iron tubbing chambers, for the Staines Urban District Council. Mr. D. C. Fidler, engineer and surveyor, Bridge Street, Staines.

Hoylake, February 1.—Automatic electrically-driven pumping plant, including pumps, motors, starting gear, piping, valves, etc., for the Urban District Council. Mr. W. H. Maitland, engineer, Town Hall, Hoylake, Wirral.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 117, Chancery Lane, London, W.C.2.)

Russell's Brass Foundry, Limited, 19, Albert Street, Motherwell.—Capital £1,500.

John Wheeler & Son, Limited, Railway Foundry, Langley, Oldbury.—Capital, £6,000. Iron founders. Directors: C. W. Wheeler and H. H. Wheeler.

Metro Metal Company, Limited.—Capital, £1,000 in £1 shares. Subscribers: S. Z. Manches, 31, Brondesbury Park, London, N.W.6; A. H. Harbour.

Personal

MR. F. C. BUSH, director and general manager of the Raleigh Works, Nottingham, will retire at the end of the month, after a connection of 46 years with the company.

AT THE ANNUAL MEETING of the Lincoln Engineering Society, Mr. E. R. Walter, M.Sc., the Principal of Lincoln Technical College, and hon. secretary of the local section of the Institute of British Foundrymen, was elected President.

MR. JOHN D. W. DAVIS, who has recently been appointed secretary of the Welsh Engineers and Founders' Association, is a son of the late Mr. William Davis, the first secretary (1887-1912) of the Royal Metal Exchange, Swansea. He is a partner in the firm of William Davis & Sons, iron, steel and metal merchants, Swansea, and since the death of his father in 1912 has been secretary of the Royal Metal Exchange. After being educated at Queen's College, Taunton, the Engineering Department, Yorkshire College, Leeds, and Victoria University, he served with the Forces in France, rising to the rank of Captain. Mr. Davis has had a distinguished sporting career. At rugby football he played for Neath, Victoria University, Cheshire, Yorkshire and Glamorganshire, and at cricket he represented Neath, Swansea and Glamorganshire. He also played hockey for Neath and South Wales. Mr. Davis has been a member of the committee of the Glamorganshire County Cricket Club for 29 years, and he is now chairman of the South Wales and Monmouthshire Cricket League. In addition he is an ex-captain, vice-president and secretary of the Swansea Bay Golf Club.

Wills

SAXON, ALFRED, for many years managing director of George Saxon, Limited, Openshaw Engineering Works ... £1,711

ALDRICH, JOHN WILLIAM, chief buyer for the English Steel Corporation, Limited, Vickers Works, Sheffield ... £1,048

Obituary

MR. JOSEPH COOK, of West Bridgford, Nottingham, died on January 20, at the age of 95 years. Before his retirement he was manager of the Butterley Company's Ironworks, Codnor Park.

MR. JAMES BLUMER, who for 40 years was associated with Messrs. Bolckow, Vaughan & Company, Limited, Middlesbrough, died in Darlington recently at the age of 80. Mr. Blumer was a native of South Shields, and entered the service of the Bolckow, Vaughan Company at Darlington. At the age of 21 he became landsale agent. When he retired he was manager of the mineral department. He also held directorships of many companies.

Forthcoming Events

Institute of British Foundrymen

JANUARY 25.

Newcastle-upon-Tyne and District Branch:—"The Technique of Chilling," Paper by J. Roxburgh, at the Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

FEBRUARY 1.

East Midlands Branch:—"A Preliminary Report on Moulding Costs by the Costing Sub-Committee of the Technical Committee," presented by a member of the Sub-Committee at the Technical College, Derby, at 6 p.m.

FEBRUARY 5.

London Branch:—"How to Reduce Core-making Costs." Paper by N. P. Newman at the Charing Cross Hotel, Charing Cross, London, W.C.2, at 8 p.m.

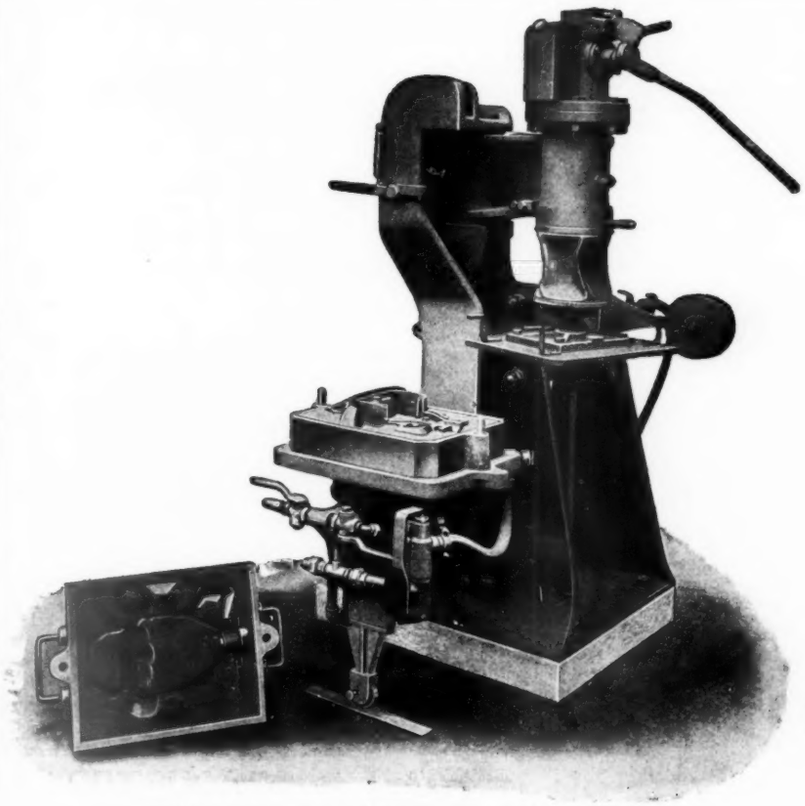
FEBRUARY 7.

Birmingham, Coventry and West Midlands Branch:—"Modern Core-Shop Production," Paper by W. H. Smith at the James Watt Memorial Institute, York House, Great Charles Street, Birmingham, at 7.30 p.m.

The Institute of Vitreous Enamellers

FEBRUARY 6.

Manchester:—"Refractories for Enamelling Muffle Furnaces." Paper by John Walker, A.R.S.M., B.Sc., at the Y.M.C.A., Peter Street, Manchester, at 7.30 p.m.



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- Warner C.B.R. and
- Low Carbon Cylinder (FOR CYLINDERS, ROLLS, ENGINEERING CASTINGS, ETC.)
- Low Carbon Malleable (FOR MALLEABLE CASTINGS OF ALL DESCRIPTIONS)

Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

● ACTUAL ANALYSIS CERTIFICATES ARE AVAILABLE WITH EACH DELIVERY

● Typical Cylinder Pig Iron Specification

TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

● Typical Malleable Pig Iron Specification

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

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Raw Material Markets

The question of prices continues to dominate business in the iron and steel trades. The more hopeful outlook in the coal-trade dispute has acted favourably on the markets, but until a final settlement has been effected between the miners and the owners, prospects will remain obscure. Obviously, with rising fuel prices some advance will have to be made in pig-iron quotations. The shortage of pig-iron continues to be apparent in the North of England, and additional blast furnaces are to be put into operation as soon as they can be got ready.

Pig-Iron

MIDDLESBROUGH.—Owing to the stringency of supplies new business is small. Manufacturers are complying with their commitments under running contracts by taking up their stocks. Export business continues to be refused. With the prospect of an increased output there should be an extensive period of heavy trade. Prices remain unchanged, but an upward movement is almost certain to be seen as soon as a settlement is effected in the coalfields. Meanwhile, No. 3 Cleveland G.M.B. is quoted at 70s. per ton delivered Middlesbrough or Falkirk, 72s. on the North-East Coast, and 73s. on Clydeside, with No. 1 foundry quality at a premium of 2s. 6d. per ton and No. 4 foundry or forge at a discount of 1s. per ton.

The demand for East Coast hematite continues to be heavy, and supplies, which were not too large, have suffered a decrease by the switching over of two blast furnaces from the manufacture of hematite to basic iron in order to meet the heavy call of the steelworks. At the moment, makers are being compelled to draw upon their stocks, and they are unwilling to enter into forward contracts. Home quotations are at fixed minima, and for No. 1 East Coast hematite are 71s. delivered Middlesbrough, 72s. on Tyneside, 73s. 6d. North-East Coast, 74s. Scotland, 78s. 6d. Sheffield, and 84s. 6d. Birmingham.

LANCASHIRE.—Foundries in this area are receiving deliveries on a good scale. According to reports from Midland makers the tonnage going into consumption locally is well up to the volume of the last quarter of 1935. Prospects for the machine-tool trade and the heavy electrical engineers are bright, and the jobbing foundries are also experiencing increased activity. Textile machinists are having fair requirements, but at the moment the state of trade is rather unsettled. There is an increased demand among hematite producers, and prices are quoted at unchanged levels of 81s. per ton for West Coast and from 80s. 6d. to 81s. for East Coast, including delivery equal to Manchester. The prices of common irons are also unaltered, Staffordshire, Derbyshire and Lancashire brands of No. 3 being on offer for delivery in the Lancashire zone at 78s. per ton, Northamptonshire brands at 76s. 6d., and Scottish No. 3 at from 83s. to 83s. 6d.

MIDLANDS.—The demand for pig-iron continues to be heavy, but supplies show no signs of becoming insufficient. New business is scarce, but that is to be expected, for most ironfounders are well covered for supplies for some months ahead. Prices are unchanged, the Association figures, delivered to Birmingham and Black Country stations, being 72s. 6d. for Northants No. 3 and 75s. for Derbyshire, Lincolnshire and North Staffordshire No. 3. These prices are subject to a small sliding-scale rebate to large consumers. The motor and general-engineering trades have improved requirements for special-quality iron. Prices are firm and are controlled. Medium-phosphorus iron is quoted from 77s. 6d. to 87s. 6d.; low-phosphorus, at 89s. to 95s.; and refined pig-iron, from £6 to £7 15s., delivered this area. Several makers of hematite are fully sold and are having to refuse new business. The nominal Association prices are unaltered at £4 4s. 6d. for West Coast mixed numbers, £4 3s. 6d. for East Coast No. 3, and £4 3s. for Welsh mixed numbers, delivered to stations in this area, with 1s. 6d. per ton added if delivered into works in 10-ton lots.

SCOTLAND.—Conditions are quite satisfactory in this area and it is a good indication for the future that shipbuilding orders on the Clyde have increased by 40 per cent. compared with three months ago. Pig-iron is in steady demand and quotations are unchanged, with No. 3 foundry at 74s. f.o.t. furnaces and 2s. 6d. per ton extra for No. 1. The Falkirk and district founders are well employed. No. 3 Cleveland is quoted at 70s. f.o.t. Falkirk and 73s. f.o.t. Glasgow, with other English foundry irons on offer at 1s. 3d. per ton below the foregoing figures. Both basic and hematite irons are being well taken up by the steelworks. Prices remain unaltered, as follow:—Mixed numbers West Coast hematite, 74s.; mixed numbers, East Coast hematite, 74s.; basic, British and Indian, 70s. (less 5s. rebate), all delivered steelworks here.

Coke

The very heavy demand for foundry coke continues to be apparent and there is no relief in the position. Pressure on the collieries for supplies remains strong. Prices vary considerably and for delivery in Birmingham and district best Durham coke ranges from 41s. 6d. to 43s., and Welsh from 36s. to 47s. 6d. per ton.

Steel

Business in the steel market continues to be on a heavy scale and the steelworks are well engaged. More confidence has been given to the market following the more favourable events in the coalfields dispute. Consuming works continue to take heavy deliveries. In the semi-finished branch of the trade business is operating to the limit of capacity, structural steel being in particularly heavy demand. All the heavy steelworks are very busy. Works engaged in shipbuilding and constructional work are still taking up heavy quantities of material, in spite of heavy tonnages which have gone into consumption over the past few months.

Scrap

The price of heavy steel scrap on the Cleveland market has been maintained at from 57s. 6d. to 60s. per ton during the past week, but it is difficult to arrange transactions at current figures. Supplies continue to be scarce. Machinery quality of heavy metal is at 62s. 6d., but only small tonnages are under contract. Clean, light cast-iron scrap is at 50s. to 51s., while cast-iron borings are quoted at 27s. 6d. per ton delivered works. Slightly firmer conditions are now prevailing on the South Wales market and the demand is maintained on a good scale. Heavy mild-steel scrap in furnace sizes has a quiet demand, but is firm at 65s. Heavy cast iron in large pieces and furnace sizes has an improved demand at 55s. to 57s. 6d., while good cast-iron machinery scrap in foundry sizes is quiet, but has a limited local demand at 60s. to 62s. 6d. per ton. All qualities of scrap are in good demand in the Midlands and higher prices are general. Mixed heavy iron and steel is at 50s. to 52s. 6d., while good heavy unsheared wrought iron is quoted between 65s. and 70s. Short heavy steel scrap, as used in the foundries, is at 60s. per ton delivered works. Satisfactory conditions also prevail on the Scottish market, where supplies are becoming scarce. Prices are firm. Heavy machinery cast-iron scrap has a good demand at 63s. 6d. to 65s., while ordinary cast-iron scrap in handy sizes is quoted about 5s. per ton less, delivered f.o.t. consumers' works.

Metals

The Metal Exchange was closed on Tuesday owing to the death of King George.

Copper.—Rather featureless conditions have prevailed in this market during the past week, but the undertone is considered to be quite sound. World consumption is likely to show a decrease in the first quarter of this year over the last three months of 1935. That is according to present indications, though it is perhaps too early to attempt to forecast conditions up to the end of March.

Daily market prices:—

Cash.—Thursday, £34 8s. 9d. to £34 10s.; Friday, £34 12s. 6d. to £34 13s. 9d.; Monday, £34 10s. to £34 11s. 3d.; Wednesday, £34 18s. 9d. to £35.

Three Months.—Thursday, £34 16s. 3d. to £34 17s. 6d.; Friday, £35 to £35 1s. 3d.; Monday, £34 17s. 6d. to £34 18s. 9d.; Wednesday, £35 6s. 3d. to £35 7s. 6d.

Tin.—Steady conditions continue in this market. The demand from industrial sources is slack, chiefly due to the fact that most concerns have not fully recovered from the stocktaking operations. The world position is summed up by Messrs. Rudolf Wolff & Company in their weekly report. They state that "demand on the part of consumers has broadened a little in this country, and a moderate business is passing on the Continent; in the United States also rather more activity has taken place, and consumption generally is reported as being satisfactory. The political unsettlement on the Continent and in the U.S.A., operating as a restraint on confidence, are subduing influences. The firm undertone, therefore, might be ascribed to the reasonably good prospects with regard to consumption, in consequence of which relatively little apprehension is felt that the increasing output will unduly depress prices, for it is realised that consumers' stocks require replenishment, and public stocks must also substantially accumulate before normal conditions return."

Metal Exchange quotations were as follow:—

Cash.—Thursday, £212 15s. to £213; Friday, £211 10s. to £211 15s.; Monday, £209 10s. to £210; Wednesday, £207 to £207 10s.

Three Months.—Thursday, £204 to £204 5s.; Friday, £203 7s. 6d. to £203 10s.; Monday, £201 10s. to £201 15s.; Wednesday, £198 15s. to £199.

Spelter.—This metal has had a rather more satisfactory appearance recently, and quotations have been steady. However, there continues to be little cause for optimism with regard to the future of the metal.

Official quotations were as follow:—

Ordinary. — Thursday, £14 3s. 9d.; Friday, £14 3s. 9d.; Monday, £14 6s. 3d.; Wednesday, £14 5s.

Lead.—Increased values have been the feature in the lead market during the past week. Buying has been on a better scale, and consumers have come into the market for moderate supplies.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £14 8s. 9d.; Friday, £14 13s. 9d.; Monday, £14 17s. 6d.; Wednesday, £15 2s. 6d.

GANISTER

Purchase your supplies from actual Producers with over 50 years' reputation

Scientifically treated, specially ground Ganister for Cupolas, Iron & Steel Works, &c.

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Est. 50 Years

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We Supply Re-Conditioned & New
SAND BLAST PLANTS
AND
AIR COMPRESSORS.

Tilghman's, Room, Barrel, Chamber, Rotary Table, Dust Arrester, and Continuous Feed Barrel Plants.

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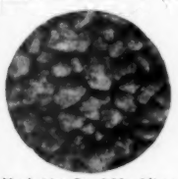
MOULDING SANDS—from our own quarries—milled in our own works

—to your specification

STEEL Moulding Sands, Iron and Non-ferrous Moulding Sands of every type—there are over fifty different grades from which to choose—are produced by us at centres situated throughout England and Scotland. With these facilities, the founder is able to gain considerable advantage by having sand delivered at low Railway rates. You cannot do better than specify a G.R. Sand whether you require it Coarse, Medium or Fine in grain and either well or weakly bonded. The Microphotographs reproduced on the right—magnified eight times—show the remarkable grain structure of just six of the Moulding Sands we supply. Information regarding the most suitable sand for your particular need and full technical details will be given without obligation.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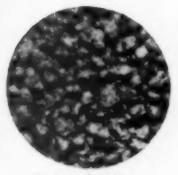
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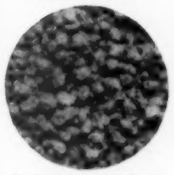
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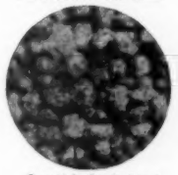
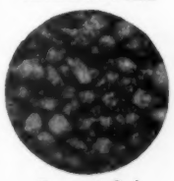
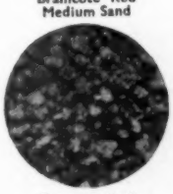

Scottish Rock Sand


Bramcote Red Medium Sand


Bramcote Red Superfine Sand

Please write for further particulars

GENERAL REFRACTORIES LIMITED

Telephone: *Sheffield* 31113 (6 *lines*).

Telegrams: "*Genefax, Sheffield.*"

Genefax House, Sheffield.

LONDON OFFICE: Russell House, Adelphi, W.C.2. Telephone: Temple Bar 7361.

SOUTH WALES OFFICE: 11, Wind Street, Swansea. Telephone: 3680.

SCOTTISH OFFICE: 156, St. Vincent Street, Glasgow. Telephone: 5250.

RAW MATERIALS—PRICE LIST

(Wednesday, January 22, 1936)

COPPER

	£	s.	d.
Standard cash	34	18	9
Three months	35	6	3
Electrolytic	39	0	0
Tough	37	5	0
Best selected	37	15	0
Sheets	66	0	0
India	48	10	0
Wire bars	39	0	0
Ingot bars	39	0	0
H.C. wire rods	42	10	0
Off. av. cash, Dec.	35	2	8½
Do., 3 mths., Dec.	35	11	1½
Do., Sttlmnt., Dec.	35	2	9
Do., Electro, Dec.	39	11	3
Do., B.S., Dec.	38	15	10
Do., wire bars, Dec.	39	16	3
Solid drawn tubes			10½d.
Brazed tubes			10½d.
Wire			6½d.

BRASS

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7½d.
Wire	7½d.
Rolled metal	7½d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN

	£	s.	d.
Standard cash	207	0	0
Three months	198	15	0
English	207	10	0
Bars	208	10	0
Straits	209	10	0
Australian	207	0	0
Eastern	206	10	0
Banca	208	0	0
Off. av. cash, Dec.	220	5	6¾
Do., 3 mths., Dec.	210	2	0
Do., Sttlmt., Dec.	220	3	9

SPELTER

	£	s.	d.
Ordinary	14	5	0
Remelted	13	0	0
Hard	12	0	0
Electro 99.9	16	8	9
English	15	7	6
India	13	5	0
Zinc dust	19	10	0
Zinc ashes	4	15	0
Off. aver., Dec.	15	3	8½
Aver. spot, Dec.	15	1	9¾

LEAD

	£	s.	d.
Soft foreign ppt.	15	2	6
Empire (nom.)	15	12	6
English	17	5	0
Off. average, Dec.	16	16	3¾
Average spot, Dec.	16	16	0¾

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	22	12	6
Do., V.M. ex-whse.	23	15	0
Rods	27	5	0

ANTIMONY

	£	s.	d.		£	s.	d.
English	72	0	0	to	73	0	0
Chinese, ex-whse.					62	0	0
Crude, c.i.f.					30	10	0

QUICKSILVER

Quicksilver 12 10 0 to 12 18 6

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.
Ferro-silicon—			
25%	8	17	6
45/50%	12	15	0
75%	17	17	6
Ferro-vanadium—			
35/50%	12/8 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	4/6 lb. Mo.		
Ferro-titanium—			
23/25% carbon-free	9d. lb.		
Ferro-phosphorus, 20/25%	£18 0 0 to £20 0 0		
Ferro-tungsten—			
80/85%	3/- lb.		
Tungsten metal powder—			
98/99%	3/3 lb.		
Ferro-chrome—			
2/4% car.	£33 0 0		
4/6% car.	£21 15 0		
6/8% car.	£21 0 0		
8/10% car.	£21 0 0		
Ferro-chrome—			
Max. 2% car.	£33 10 0		
Max. 1% car.	£36 5 0		
Max. 0.70% car.	£37 5 0		
70% carbon-free	9½d. lb.		
Nickel—99.5/100%	£200 to £205		
"F" nickel shot	£184 0 0		
Ferro-cobalt, 98/99%	5/6 lb.		
Metallic chromium—			
96/98%	2/5 lb.		
Ferro-manganese (net)—			
76/80% loose	£10 15 0 to 11 5 0		
76/80% packed	£11 15 0 to 12 5 0		
76/80% export	(nom.) £9 15 0		
Metallic manganese—			
94/96% carbon-free	1/3 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to 1/16 in. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in. 3d. lb.
Do., under ⅜ in. × ¼ in. 1/- lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

SCRAP

South Wales—	£	s.	d.		£	s.	d.
Heavy steel					3	2	6
Mixed iron and steel					3	0	0
Heavy cast iron	2	15	0	to	2	17	6
Good machinery	3	0	0	to	3	2	6
Cleveland—							
Heavy steel	2	17	6	to	3	0	0
Steel turnings					1	17	6
Cast-iron borings					1	7	6
Heavy cast iron					3	0	0
Heavy machinery					3	2	6
Midlands—							
Light cast-iron scrap					2	10	0
Heavy wrought iron	3	5	0	to	3	10	0
Steel turnings	2	0	0	to	2	2	6
Scotland—							
Heavy steel					2	12	6
Ordinary cast iron	2	18	6	to	3	0	0
Engineers' turnings					2	1	3
Cast-iron borings	1	17	6	to	2	0	0
Wrot-iron piling					3	5	0
Heavy machinery	3	3	6	to	3	5	0

London—Merchants' buying prices, delivered yard.

	£	s.	d.		£	s.	d.
Copper (clean)					28	0	0
Brass					18	0	0
Lead (less usual draft)					13	0	0
Tea lead					9	0	0
Zinc					8	0	0
New aluminium cuttings					74	0	0
Braziery copper					25	0	0
Gunmetal					27	0	0
Hollow pewter					155	0	0
Shaped black pewter					120	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	72/6
Foundry No. 3	70/-
,, at Falkirk	70/-
,, at Glasgow	73/-
Foundry No. 4	69/-
Forge No. 4	69/-
Hematite No. 1	71/-
Hematite M/Nos.	70/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	74/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	71/-
,, No. 3 fdry.	75/-
Northants forge	68/6
,, fdry. No. 3	72/6
,, fdry. No. 1	75/6
Derbyshire forge	71/-
,, fdry. No. 3	75/-
,, fdry. No. 1	78/-
Scotland—	
Foundry No. 1, f.o.t.	76/6
,, No. 3, f.o.t.	74/-
Hem. M/Nos. d/d	73/6
Sheffield (d/d district)—	
Derby forge	68/6
,, fdry. No. 3	72/6
Lincs forge	68/6
,, fdry. No. 3	72/6
W.C. hematite	86/-
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	78/-
Staffs fdry. No. 3	78/-
Northants fdry. No. 3	76/6
Cleveland fdry. No. 3	78/-
Dalzell. No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	83/-
Clyde, No. 3	83/-
Monkland, No. 3	83/-
Summerlee, No. 3	83/-
Eglinton, No. 3	83/-
Gartsherrie, No. 3	83/-
Shotts, No. 3	83/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	12	6	to	9	15	0
Nut and bolt iron	7	17	6	to	8	7	6
Hoops	10	10	0	and up.			
Marked bars (Staffs) f.o.t.	12	0	0				
Gas strip	10	10	0	and up.			
Bolts and nuts, ¾ in. × 4 in.	15	5	0	and up.			
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	9	5	0	to	9	7	6
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ¼ in. (Untested)					8	12	0
Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates	12	5	0	to	12	10	0
Hoops (Staffs)					9	7	0
Black sheets, 24g. (4-t. lots)					11	10	0
Galv. cor. shts. (,,)					13	10	0
Galv. flat shts. (,,)					14	0	0
Galv. fencing wire, 8g. plain					15	10	0
Billets, soft	5	10	0	and up.			
Billets, hard	6	17	6	to	7	2	6
Sheet bars	5	10	0	to	5	15	0
Tin bars	5	10	0	to	5	15	0

PHOSPHOR BRONZE

	Per lb. basis.
Strip	10½d
Sheet to 10 w.g.	11½d.
Wire	12½d.
Rods	11½d.
Tubes	14d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	21.31
No. 2 foundry, Valley	19.50
No. 2 foundry, Birm.	15.50
Basic, Valley	19.00
Malleable, Valley	19.50
Grey forge, Valley	19.00
Ferro-mang. 80%, seaboard	75.00
O.-h. rails, h'y, at mill	36.37½
Billets	29.00
Sheet bars	30.00
Wire rods	40.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.40
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 32/6
,, furnace	20/-
Durham foundry	21/6
,, furnace	19/6
Scotland, foundry	28/-
,, furnace	25/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		18/9 to 19/-
,,	28×20	,,	37/6 to 38/-
,,	20×10	,,	27/- to 28/-
,,	18¾×14	,,	19/6
C.W.	20×14	,,	15/9
,,	28×20	,,	33/9
,,	20×10	,,	23/-
,,	18¾×14	,,	16/-

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	6	0	0	to	7	0	0
Bars-hammered, basis	16	0	0	to	16	10	0
Bars and nail-rods, rolled, basis	15	15	0	to	16	0	0
Blooms	10	0	0	to	12	0	0
Keg steel	30	0	0	to	31	0	0
Faggot steel	18	0	0	to	23	0	0
Bars and rods dead soft, st'l	10	0	0	to	12	0	0

All per English ton, f.o.b. Gothenburg
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.	
Jan. 16 ..	34	8	9	dec. 1/3
„ 17 ..	34	12	6	inc. 3/9
„ 20 ..	34	10	0	dec. 2/6
„ 21 ..				
„ 22 ..	34	18	9	inc. 8/9

Electrolytic Copper

	£	s.	d.	
Jan. 16 ..	38	5	0	dec. 5/–
„ 17 ..	38	10	0	inc. 5/–
„ 20 ..	38	10	0	No change
„ 21 ..				
„ 22 ..	39	0	0	inc. 10/–

Standard Tin (cash)

	£	s.	d.	
Jan. 16 ..	212	15	0	No change
„ 17 ..	211	10	0	dec. 25/–
„ 20 ..	209	10	0	„ 40/–
„ 21 ..				
„ 22 ..	207	0	0	dec. 50/–

Tin (English ingots)

	£	s.	d.	
Jan. 16 ..	213	0	0	No change
„ 17 ..	211	15	0	dec. 25/–
„ 20 ..	210	0	0	„ 35/–
„ 21 ..				
„ 22 ..	207	10	0	dec. 50/–

Spelter (ordinary)

	£	s.	d.	
Jan. 16 ..	14	3	9	dec. 2/6
„ 17 ..	14	3	9	No change
„ 20 ..	14	6	3	inc. 2/6
„ 21 ..				
„ 22 ..	14	5	0	dec. 1/3

Spelter (Electro, 99.9 per cent.)

	£	s.	d.	
Jan. 16 ..	16	6	3	dec. 3/9
„ 17 ..	16	6	3	No change
„ 20 ..	16	8	9	inc. 2/6
„ 21 ..				
„ 22 ..	16	8	9	No change

Zinc Sheets (English)

	£	s.	d.	
Jan. 16 ..	22	10	0	dec. 2/6
„ 17 ..	22	10	0	No change
„ 20 ..	22	12	6	inc. 2/6
„ 21 ..				
„ 22 ..	22	12	6	No change

Lead (English)

	£	s.	d.	
Jan. 16 ..	16	10	0	dec. 5/–
„ 17 ..	16	15	0	inc. 5/–
„ 20 ..	17	0	0	„ 5/–
„ 21 ..				
„ 22 ..	17	5	0	inc. 5/–

Imports and Exports of Pig-Iron, Iron and Steel Castings, etc., in December and the twelve months, 1935, compared with a year ago.

	December.		Twelve months.		December.		Twelve months.	
	1934.	1935.	1934.	1935.	1934.	1935.	1934.	1935.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron—from British India	10,566	6,680	110,027	67,401	31,019	20,644	310,964	201,502
„ Foreign Countries	1,718	2,050	15,629	16,854	9,693	11,585	89,564	97,998
Total	12,284	8,910	125,656	84,255	40,712	32,229	400,528	299,500
Castings and forgings	297	532	3,855	3,510	8,942	16,230	98,461	97,472
Cast pipes and fittings	64	189	1,037	1,735	2,181	4,153	51,938	44,247
Stoves, grates, etc.	77	77	1,176	1,117	6,487	4,258	93,314	90,325
Baths	539	560	7,751	6,820	15,434	14,038	195,811	180,402
Hollow-ware, all kinds	115	208	2,232	2,588	8,493	14,049	131,697	170,990
Exports.								
Pig-iron, forge	74	488	1,298	2,228	328	2,246	5,402	9,681
„ foundry	5,436	5,115	73,235	91,935	17,968	17,813	250,068	316,861
„ acid	4,558	3,705	47,910	49,213	14,567	12,757	151,417	160,187
„ basic	—	—	842	829	—	—	2,796	2,650
Total	10,068	9,308	123,285	144,205	32,863	32,816	409,683	489,379
Castings and forgings	558	266	5,663	4,055	19,098	11,162	216,789	154,185
Cast pipes and fittings, up to 6 in. diameter	4,516	4,471	61,015	58,832	53,322	52,165	682,820	656,414
„ „ „ „ over 6 in.	2,800	5,037	36,938	36,574	26,290	41,356	280,695	299,107
Stoves, grates, etc.	846	961	8,925	9,270	45,735	48,060	442,066	471,500
Sanitary cisterns	249	258	2,999	3,135	7,256	8,638	87,829	93,292
Bedsteads, inc. tubes therefor	381	421	4,794	4,625	13,556	15,299	162,877	169,809
Cast hollow-ware	349	457	3,807	4,422	12,756	15,598	145,060	161,362

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APPLICATIONS are invited from foundry metallurgists which will outline (*a*) their experience in actual moulding; (*b*) their metallurgical qualifications and experience; (*c*) knowledge of languages; (*d*) age, and (*e*) comment upon their willingness to travel abroad. Applications will be treated in confidence.—Box 1234, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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